DOCUMENT RESUME

ED 308 333 CE 052 715

TITLE	Related Skills in the Marketplace. Final Report.
INSTITUTION	John C. Calhoun State Community Coll., Decatur, AL.
SPONS AGENCY	Alabama State Dept. of Education, Montgomery.
PUB DATE	Jun 89
NOTE	137p.
PUB TYPE	Reports - Research/Technical (143)
EDRS PRICE	MF01/PC06 Plus Postage.
DESCRIPTORS	Air Conditioning; Auto Mechanics; *Basic Skills; Communication Skills; Community Colleges; Cosmetology; Design; Drafting; Educational Research; Electronic Technicians; *Job Skills; *Language Skills; *Mathematics Skills; Postsecondary Education; Refrigeration; Refrigeration Mechanics; *Technical Education; Two Year Colleges
IDENTIFIERS	John C Calhoun State Community College AL

ABSTRACT

A study identified related skills needed in five diploma programs offered in the Technical Division of John C. Calhoun State Community College in Decatur, Alabama. The programs were automotive technology, refrigeration/air conditioning, electrical technology, design drafting technology, and cosmetology. Thirty-five area businesses and industries that hired employees in the five selected occupational areas were surveyed to determine which skills in mathematics and communications were needed in each of the occupations and to determine if there was a core of skills needed by all five occupations. The survey was conducted in small group meetings; follow-up visits were made to some businesses to review training materials and programs. All listening, oral communication, and reading skills listed on the survey were considered necessary or highly desirable for all occupations. No clear pattern of responses to written communication skills emerged. Mathematics competencies needed for all occupations were basic computational skills, measurement and conversion skills, and problem-solving skills related to ratio and proportions and the use of formulas. Most communication skills surveyed were generic and had application across all occupational areas. However, certain math skills varied in their application to different occupations. A review of research on related skills was conducted as part of the study. Recommendations for curriculum improvement were made. (The survey instrument and 25 references are included.) (YLB)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

CE

ED308333

RELATED SKILLS IN THE MARKETPLACE

**A Program Improvement/Innovation
And Expansion Grant
Funded by the Alabama State Department
of Education**

**FINAL REPORT
June, 1989**

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☐ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

W Teague

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

**John C. Calhoun Community College
Technical Division
P. O. Box 2216
Decatur, Alabama 35609-2216**

CE053715

BEST COPY AVAILABLE

RELATED SKILLS IN THE MARKETPLACE

A Program Improvement/Innovation
And Expansion Grant
Funded by the Alabama State Department
of Education

FINAL REPORT
June, 1989

John C. Calhoun Community College
Technical Division
P. O. Box 2216
Decatur, AL 35602

PROJECT STAFF
Robert Rose, Dean of the Technical Division
Marilyn Lewis, Project Director

TABLE OF CONTENTS

	Page
Introduction	1
Overview of the Project	2
Objectives of the Project	3
Procedures	4
Review of Research	5
Review of Related Instruction in Alabama Technical and Community Colleges	24
Implications for Calhoun	31
Survey of Mathematics and Communication Skills	33
Participating Businesses and Industries	34
Administration of the Survey	35
Analysis of Survey Data	35
Description of the Instrument	36
Limitations of the Instrument	37
Summary of Discussions with Businesses and Industry	38
Summary of Responses for Section B of the Survey	41
Analysis of Survey Checklist Data for Mechanics	43
Percentage of Response Table for Mechanics	46
Graphs of Survey Responses	50
Analysis of Survey Checklist Data for Electricians	56
Percentage of Response Table for Electricians	59
Graphs of Survey Responses	63

Page

Analysis of Survey Checklist Data for Air Conditioning/Refrigeration Technicians 69

Percentage of Response Table for Air Conditioning/Refrigeration Technicians 72

Graphs of Survey Responses 76

Analysis of Survey Checklist Data for Drafters 82

Percentage of Response Table for Drafters 85

Graphs of Survey Responses 89

Analysis of Survey Checklist Data for Cosmetologists 95

Percentage of Response Table for Cosmetologists . . . 98

Graphs of Survey Responses 102

Common Related Skills 108

Specialized Communication Skills 112

Specialized Math Competencies 113

Recommendations for Curriculum Improvement 117

Appendix: Survey Instrument 121

References 130

INTRODUCTION

"Related Skills in the Marketplace" grew out of the recognition that increasingly high levels of literacy are needed by today's workforce. Only through curriculum assessment can technical education programs keep pace with the changing needs of commerce and industry. Calhoun Community College is committed to insuring that students are equipped with the skills required for optimal performance in their chosen careers.

Related instruction in communication skills and mathematics is a vital component of the Technical College curriculum. This project has provided a base for program improvement in related studies. We are grateful to the members of the business and industrial community and our colleagues in the postsecondary system for their valuable input and assistance.

OVERVIEW OF THE PROJECT

"Related Skills in the Marketplace" was a curriculum project of the Technical Division of John C. Calhoun State Community College funded with a program improvement/ innovative and expansion grant from the Alabama State Department of Education. The goal of the project was to conduct a study that would provide a basis for improving related instruction in mathematics and communication skills and in turn help students achieve greater success in their vocational studies as well as greater success in the workplace.

The project involved the identification of related skills needed in five (5) diploma programs offered in the Technical Division of Calhoun College. The programs were:

Automotive Technology
Refrigeration/Air Conditioning
Electrical Technology
Design Drafting Technology
Cosmetology

A survey of area businesses and industries which hire employees in the five (5) selected occupational areas was conducted. Survey data was analyzed to determine common related skills in all five (5) occupations as well as specialized skills.

A review of research on related skills was conducted as well as a review of related instruction in technical colleges across the State. In addition to the identification of skills, recommendations for curriculum improvement were made.

OBJECTIVES OF THE PROJECT

The project was designed to accomplish three (3) principal objectives:

1. A curriculum specialist will be hired and will conduct surveys of at least three industries/businesses for five (5) technical/vocational diploma (certificate) programs of study offered by Calhoun College. These programs are: Automotive Technology, Cosmetology, Design Drafting Technology, Electrical Technology, and Refrigeration/Air Conditioning.

2. A curriculum specialist, in conjunction with the technical faculty, will research current literature, State guidelines, and proposals relative to the enhancement of communication and math skills in vocational/technical degrees and certificates (diploma). He/she will also meet with faculty on at least three occasions for discussion of curriculum renovation.

3. The curriculum specialist will submit to the Dean of the Technical College validated recommendations for the specialized communications and mathematics skills needed in the five (5) specific programs of study.

The curriculum specialist began work on the project February 1, 1989. Objectives were completed June 30, 1989.

PROCEDURES

A curriculum specialist was hired to serve as Project Director and implement the objectives of the project. The curriculum specialist worked with the faculty to:

(a) develop an instrument to survey businesses and industry to determine which communication and mathematics skills are needed for optimal job performance in five (5) vocational areas.

(b) identify businesses and industries to participate in the survey.

The curriculum specialist reviewed research on related instruction and reviewed related instruction programs across the State of Alabama. Findings were shared with faculty and administrators and with participating businesses and industries. Common related communication and mathematics skills were identified as well as specialized skills.

Areas of concern in the related instruction program were identified and recommendations for curriculum improvement were proposed.

REVIEW OF RESEARCH

A review of research was conducted to identify studies on the identification of basic skills for the occupations addressed in the project. Manual and computer searches were used to identify the most pertinent literature. A significant body of literature exists on the inclusion of basic skills instruction in the secondary vocational curriculum but relatively few studies address basic skills instruction at the postsecondary level.

The need for improved basic skills instruction in vocational programs is well documented. According to Perishing & Gillie (1988) school systems have underestimated the importance of basic skills for success in the workplace. Employers find large numbers of employees lacking skills in listening, speaking, reading, writing and reasoning and such deficiencies limit the upward mobility of workers as well as their ability to adapt to changes in the workplace. Hamilton (1982) asserts that vocational students need to focus on the acquisition of general knowledge and skills and not view their occupational study as a substitute for academic achievement.

Basic Literacy and Communication Skills

Mikulecky & Drew (1988) synthesized research on basic literacy skills for vocational training in "Basic Literacy and Communication Skills for Vocational Training." They report that "the amount of complexity of literacy demands

appears to be increasing in most sectors of the workplace" (p.3). One study (Diehl and Mikulecky, 1980) examined 180 workers from a cross-section of occupations and found that workers averaged nearly two (2) hours a day reading print, charts, graphs and information on computer terminals. Reading materials on the job ranged from ninth to twelfth grade levels for 70 percent of the on-the-job reading. Mikulecky (1982) compared literacy demands of high school to the workplace and found work materials were generally as difficult or more difficult than high school materials.

The way basic skills are used in the workplace differs from school. Workplace reading, writing and computation is done to accomplish tasks and make assessments. Research by Mikulecky and Winchester (1983) and Mikulecky and Ehlinger (1989) indicates a strong relationship between higher-level "metacognitive" and problem-solving reading abilities and job performance across different occupations.

"The ability to set purposes, self-question, summarize information, monitor comprehension, and make useful notes distinguishes superior job performers from merely adequate job performers." (Mikulecky and Drew, 1988, p.4). The research shows that the ability to read and apply information obtained from complex textual and graphic materials is a major factor in determining success in the workplace. Over 90 percent of occupations call for some reading and writing. The most heavy job related reading is performed by new workers learning new jobs (Kern, 1980).

The general trend is toward higher literacy requirements in the workplace. As technology continues to impact the workplace the need for training and retraining steadily increases and workers must have strong learning skills.

James Bishop of the National Center for Research in Vocational Education asserts that for success on the job, the ability to learn things fast is critical. He says the key is communication and reasoning abilities (Miguel, 1985). The research on literacy in the workplace indicates that: "Reading ability, as indicated by higher level problem-solving and metacognitive skills rather than factual level reading ability, appears to be a significant predictor of overall job performance" (Mikulecky & Drew, 1988, p.14).

Greenan (1983) identified four reading skills as highly important for students in industrial maintenance occupations:

* read, understand and find information or gather data from books, manuals, and directories;
* read and understand forms;
* read and understand short notes, memos, and letters;
* read and understand graphs, charts, and tables to obtain factual information.

These skills are also specialized since the reading content varies from one occupation to another. Reading a chart for one occupation may require different skills than those required to read a chart from a different occupation. Students need to use materials similar to those in the

workplace. Such materials can be designed and integrated in to the curriculum. The task analysis approach to identifying basic skills is useful in this regard (Mikulecky & Drew, 1988).

L. Jay Thornton (1980) in a report titled Basic Reading Skills and Vocational Education developed for the National Center for Research in Vocational Education, discusses issues related to reading in the vocational curriculum. Thornton defines occupational reading and asserts that reading be addressed as a vocational skill.

> Occupational reading requirements include those skills necessary for basic literacy and skills peculiar to the occupational specialty. Vocabulary, semantics, and syntax in literature pertinent to the completion of an occupational task are different from those contained in literature read for entertainment, understanding of concepts, or information. Because occupational specialties contain reading requirements which depart from reading for basic literacy, reading needs to be addressed as a vocational skill, and reading instruction is appropriate in the vocational educational curriculum (Thornton, 1980, p.3,4).

Research on reading in vocational education has focused on three topics: (a) vocational program prerequisites; (b) analysis of textbooks and related literature; and (c) program development for specific target groups. Establishing prerequisite reading levels is one means of insuring student success. On the other hand, research also shows that access to programs can be increased when reading deficiencies are identified and corrected (Thornton, 1980).

Several studies have focused on the analysis of textbook readability levels. Karnes and Ginn (1976) compared the reading comprehension levels of postsecondary

vocational technical students with the readability levels of textbooks used in Mississippi vocational facilities and found a discrepancy between the mean reading ability levels of the students and the mean readability grade level of selected texts to be 3.51 grades for vocational students and 1.94 grades for technical students. Scott-Hunter (1978) examined reading levels of vocational text materials and found that of textbooks to be at a higher mean grade readability level than the mean grade reading levels of students. Caffey (1975) examined the readability of selected welding and air conditioning/refrigeration textbooks and based on tests of students' reading levels, concluded the texts were too difficult for the students to be successful.

Thornton (1980) found that the reading deficiencies of vocational students for the most part are considered academic deficiencies and are referred for remediation outside the vocational program. Many of these programs emphasize reading with only a marginal relationship to the vocational program. Very little effort has been made to determine if occupational reading requirements are similar to educational requirements. Some programs manipulate curriculum materials to reduce the readability levels to approximate the reading levels of students. His general assessment of vocational reading programs is:

> Reading programs within vocational education generally fall into five categories. In some cases, students are referred to a reading specialist for remediation. In others, vocational English courses are offered in

> prevocational programs or in conjunction with vocational programs. Often vocational curricula are modified to reduce reading requirements or avoid reading problems altogether. Under some programs, vocational educators teach reading in their classrooms and shops. Finally, many programs emphasize reading as a target activity only marginally related to the vocational program (Thornton 1980, p.7).

The need for listening instruction is discussed by Judy Nixon and Judy West in an article titled "Listening-The New Competency." They note that while listening is the most frequently used communication skill, as well as possibly the most important skill, listening receives little instruction time. Workers spend about 60 percent of the work-day listening. Only eight percent of instruction in communication skills is directed toward listening. Recognizing that poor listening skills are costly, business and industry have instituted listening training programs (Nixon and West, 1989).

Basic Mathematics Skills

The issue of how best to teach basic math skills to vocational students cannot be resolved until there is agreement on which skills are basic. Traditionally, basic math instruction has meant adding, subtracting, multiplying, and dividing numbers. Calculators and computers have eliminated the need for tedious calculations. An advisory committee of the National Council of Teachers of Mathematics reported in 1985:

> The major influence of technology on mathematics education is its potential to shift the focus of instruction from an emphasis on manipulative skills to an emphasis on developing concepts, relationships,

> structures and problem solving skills ("Impact of Computing Technology on School Mathematics: Report on an NCTM Conference", 1985, p. 14).

While basic computation skills are essential, the presence of calculators and computers allows for a shift of focus from calculating quickly to knowing when to apply certain kinds of computational procedures. This latter focus is more necessary in work-related situations (Gillie and Kloosterman, 1988).

The National Council of Supervisors of Mathematics (NCSM) outlined what is perceived to be basic mathematical skills areas. They are:

1. Problem solving.
2. Applying mathematics to everyday situations.
3. Alertness to the reasonableness of results.
4. Estimation and approximation.
5. Appropriate computational skills.
6. Geometry.
7. Measurement.
8. Reading, interpreting, and constructing tables, charts, and graphs.
9. Using mathematics to predict.
10. Computer literacy.
("Position Statement on Basic Skills", 1978, pp. 148-150)

The National Council of Teachers of Mathematics in a document titled An Agenda for Action: Recommendations for School Mathematics of the 1980's, (1980, p.1) makes the following recommendations.

1. Problem solving should be the focus of school mathematics in the 1980's; and,
2. Basic skills in mathematics must be defined to encompass more than computational facility.

Problem solving was given primary importance by both

the National Council of Supervisors of Mathematics and the National Council of Teachers of Mathematics.

> Problem solving means solving work-related problems as well as being able to transfer knowledge about one problem to a new problem and to develop several possible solutions to a problem when information necessary for an exact answer is not known. In addition, problem solving means being able to communicate ideas for problem solution to other individuals so that a group can work together to solve a quantitative question. In short, problem solving, as we are defining it, can be thought of as synonymous with the "critical thinking" or "logical thinking" necessary to answer a question, regardless of whether that answer requires one step or 50 (Gillie and Kloosterman, p.4).

The National Science Board Commission on Pre-college Education in Mathematics, Science, and Technology recommends a curriculum for all students that includes the following:

Algebra

* Ability to recognize basic algebraic forms and how to transform them into other forms
* Understanding of the logic behind algebraic manipulations
* Skill in solving linear equations and inequalities
* Skill in solving quadratic equations
* Ability to graph linear and simple quadratic functions and use these in interpreting and solving problems
* Familiarity with permutations, combinations, and simple counting problems
* Knowledge of relations and functions
* Development of problem-solving abilities

Geometry

* Ability to think logically
* Ability to work through short sequences of rigorously developed materials while de-emphasizing proof

* Knowledge of two- and three-dimensional figures and their properties

* Ability to think in two- and three-dimensions in terms of congruence and similarity

* Ability to use the Pythagorean theorem and special right triangle relationships

* Understanding of algebraic methods in geometry and analytic geometry; and vector algebra, especially in three dimensions

* Familiarity with computer graphics packages to get a visual sense of geometric concepts and transformation

Other Mathematics

* Knowledge of discrete mathematics (basic combinations graph theory, discrete probability)

* Understanding of elementary statistics (data analysis interpretation of tables, graphs, surveys, sampling)

* Knowledge of computer science (programming, introduction to algorithms and iteration)

* Familiarity with the philosophical basis of calculus and understanding of the elementary concepts of the subject (e.g., rates of change, intuitive idea of limits). (Educating Americans for the 21st Century, 1983)

Generic Skills

While the increased need for basic skills training as a requirement for good vocational training has been acknowledged for some time, experts have had limited knowledge about how to design programs which effectively incorporate basic skills into vocational training. The assumption has been that once the "basics" have been learned they can be easily transferred to the workplace or vocational training setting. The challenge for this approach is to determine which competencies comprise the basics. The counter

argument to this approach is the theory that people learn the basics better when they are integrated with actual job training. Researchers from both schools of thought share the goal of improving basics skills instruction for vocational students. While research suggests that some basic skills may be generic, other research indicates that transfer on the part of the learner is often severely limited. While it is useful to know similarities across occupations it is generally agreed that the most effective vocational basic skills programs integrate basic skills training with actual job training thereby avoiding the risk of mistakenly assuming transfer or counting on generic skills. Studies done on generic skills generally identify five skill areas as generalizable. They are mathematics, communication, interpersonal relations, reasoning, and manipulative skills.

James Greenan's 1983 study, "Identification of Generalizable Skills in Secondary Vocational Programs", is the most thorough study in this area. Greenan surveyed nearly 600 vocational teachers to see which skills they perceived to be most important in determining student success in 32 vocational areas, including agricultural, business, marketing, health, home economics, and industrial occupations training programs. Greenan found that mathematics, inter-personal relations, and reasoning skills were rated very important for industrial occupations and were therefore generalizable across programs. However,

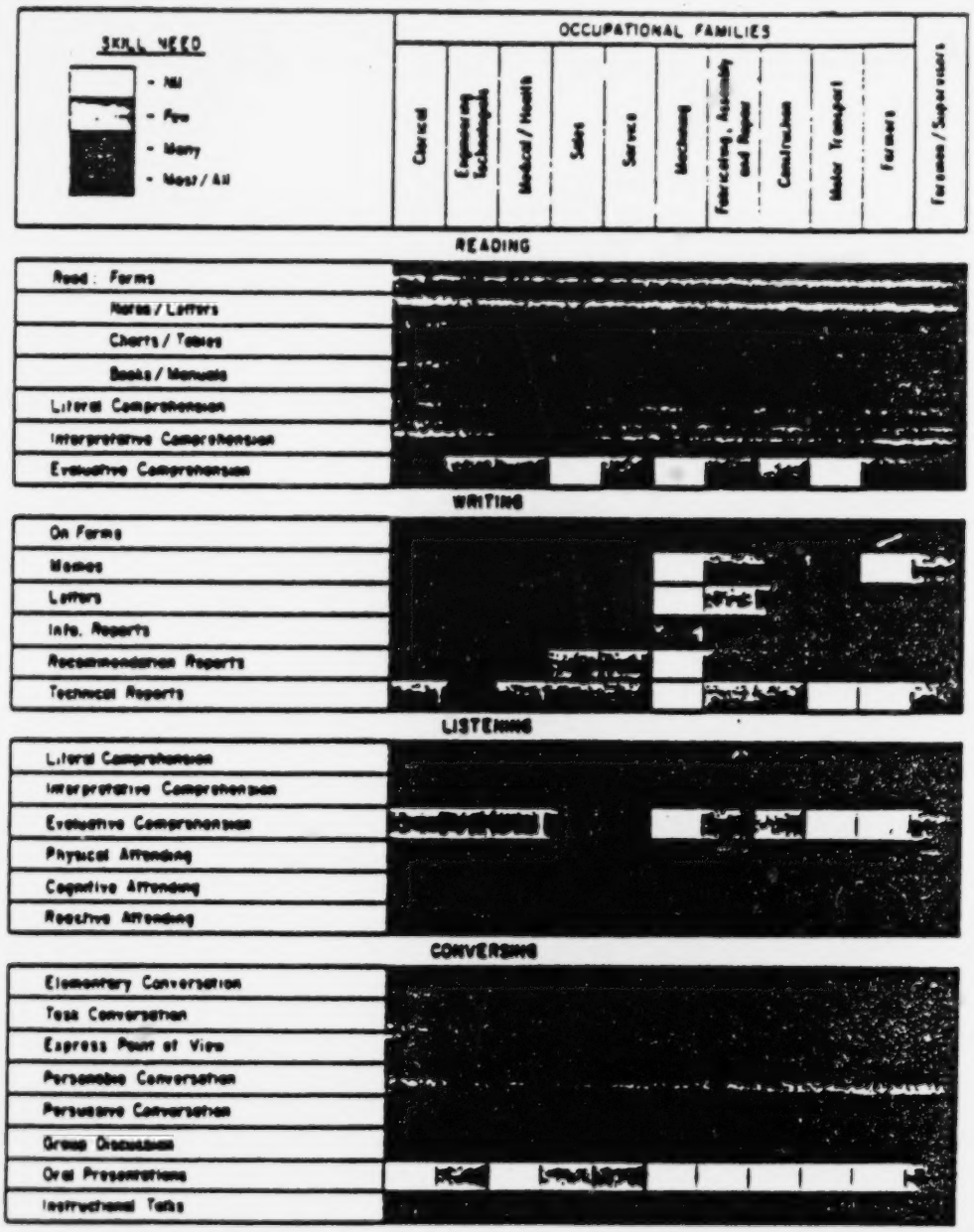
Greenan's instrument included only basic math skills in the areas of whole numbers, fractions, decimals, percent, mixed operations, measurement and calculations, and estimation.

Cheng Liu (1980) summarizes several studies on generic skills. Cheng cites a generic skills project conducted by the Advanced Development Division of the Occupational and Career Analysis and Development Branch of the Canada Employment and Immigration Commission. The Canadian project formulated generic communication and mathematics skills requirements for 10 occupational families in an attempt to provide flexibility in job training. The relative need for skills in reading, writing, listening, and conversing in selected occupational families was identified. Math skills were divided into three areas: arithmetic, geometric figures and intermediate mathematics. Communication skills were divided into four areas: reading, writing, listening, conversing. The occupational families included Clerical, Engineering Technologies, Medical/Health, Sales, Services, Machining, Fabricating, Assembly and Repair, Construction, Motor Transport, Farmers, and Foremen and Supervisors. Figures 1 and 2 summarize the generic communications and mathematics skills requirements for occupational families in the Canadian study.

Liu (1980) also cites the occupational analysis approach developed by the Instructional Materials

Figure 1

CANADIAN APPROACH'S GENERIC COMMUNICATION SKILLS*

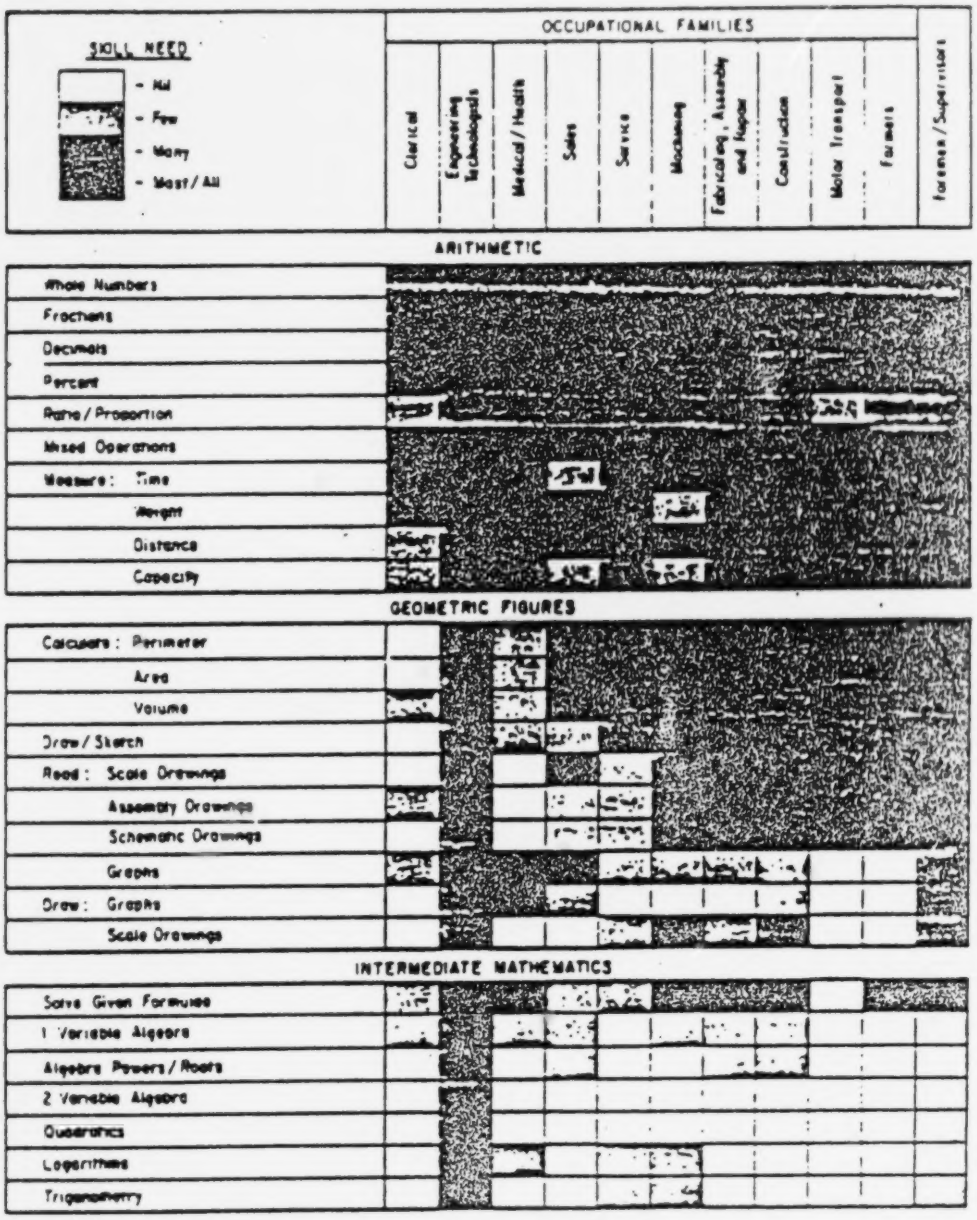


Cheng, C. Liu., Teaching Basic Skills through Vocational Education. Technical Report. p.11

* Smith (1978)

Figure 2

CANADIAN APPROACH'S GENERIC MATHEMATICS SKILLS*



Cheng, C. Liu., Teaching Basic Skills through Vocational Education. Technical Report. p.10

* Smith (1978)

Laboratory, Trade and Industrial Education division of the Ohio State University in conjunction with the Ohio State Department of Education, Division of Vocational Education. The approach involved training vocational educators to analyze specific job tasks including identification of basic skills in communication and math needed to perform the tasks. Mikulecky and Drew (1988) describe task analysis as an effective approach to identifying basic skills for vocational education. They developed a task analysis and development model for teachers. The model follows.

TASK ANALYSIS AND DEVELOPMENT MODEL FOR TEACHERS

BEFORE

1. Choose an occupation
2. Identify frequent and/or highly critical tasks involving basic skills

DURING

3. Interview an experienced worker about the reading, writing, and computation done on the job
4. Interview the worker's supervisor about job tasks
5. Observe the worker reading, writing and performing computational tasks on the job

AFTER

6. Gather samples of reading, writing, and computational materials
7. On basis of observation, interviews, and materials, further analyze the job tasks
8. Identify technical vocabulary
9. Create cloze tests with material from the job
10. Create exercises that simulate the job task

(Larry Mikulecky and Rod Drew, "Basic Literacy and Communication Skills for Vocational Training", 1988, p. 2-31)

Two studies which attempted to identify entry level basic skills for vocational education were reviewed. One study conducted by Cumberland County College in Vineland, New Jersey determined that remediation of basic skills deficiencies has an effect on the successful completion of vocational courses. Textbooks for vocational courses were analyzed to determine needed achievement levels in basic skills. Textbook analyses indicated the need for a solid foundation in reading and math skills for maximum student achievement. Appropriate course sequences were set based on text analyses. (Cumberland County College, 1981-82)

James Gray's study, Applied Math and Science Levels Utilized in Selected Trade and Industrial Vocational Education (1985), identified the level of applied mathematics and science used in selected trade and industrial subjects taught in the Kentucky Vocational Education System. The study examined the math content of carpentry, electricity/electronics, and machine shop by gathering data from teacher surveys of math skills. The study found that carpentry and machine shop covered over 50 percent of the general math and geometry skills. Electricity/electronics covered 61.76 percent of all algebra topics (Gray, 1985).

Research on specific skills needed for various vocational technical programs indicates that while differing computing skills are needed in various occupations, mastery

of fundamental computing skills are a minimum requirement and higher math skills are needed in technically oriented specialties.

Responses to the Need for Related Skills Curriculum Development

In response to the need for a math curriculum that meets the needs of vocational students the Center for Occupational Research and Development in coordination with a consortium of state directors of vocational education, has developed a comprehensive program in Applied Mathematics. The program consists of 25 modules which can be infused into existing courses or used as a stand alone course. The materials focus on problem solving techniques, calculator skills, measurement skills, geometry, data handling, simple statistics, algebraic formulas and trigonometry. The materials provide for application in all major areas of vocational education.

A program in Applied Communication has recently been developed by the Agency for Instructional Technology in coordination with a consortium of state directors of vocational education. The program is designed to teach communication skills as they apply in the workplace. The program consists of 15 modules which can be taught as a course or can be used singly to broaden existing communications courses.

Modules include topics such as Communicating in the Workplace, Using Problem-Solving Strategies, Making and Responding to Requests, Communicating with Supervisors, and

Following and Giving Directions. Emphasis is placed on simulating real workplace communication skills.

Applied Mathematics and Applied Communication are examples of the type of curriculum development needed to meet the related skills needs of vocational students. There is a need for continued research and development.

Campbell and Wood (1987) in an article titled "General Education in the Occupational Curriculum. Why? To What Extent? With What Results?" discuss the need for community colleges to evaluate the general education components of the occupational curriculum. They identify the "lack of coordinated effort between general education and occupational faculties in defining outcomes and developing courses" as one issue which needs to be addressed. They also identify course content as another major issue in the integration of general education into occupational curricula. Campbell and Wood assert that:

> The competency based education movement, which has had a major impact on many occupational programs in recent years, has forced curriculum developers to seriously address the identification of specific skills necessary for each occupational program. The general education component in these programs has proved a difficult arena in which to complete this type of skill-identification process. In most cases, program developers agree that reading, writing, thinking, analysis, and adaptation skills need to be taught, but often these skills are still vaguely defined and remain difficult to measure. Specific general education courses designed to teach these skills to occupational students have not been developed (Campbell and Wood, 1987, p. 68).

SUMMARY OF RESEARCH

Current research indicates that workplace literacy demands are increasing. The ability to gather information from varied sources and apply it the solution of problems is essential. This often requires complex reading, listening and reasoning skills. In addition to computational facility the ability to select appropriate operations to solve problems is a critical math skill area. Vocational education has not kept up with the basic skills needs of people entering the workforce.

Researchers have tried to identify generic skills which apply to a cross section of occupations and generally agree that basic math and communication skills are transferrable but the practical application of skills in specific vocational training is crucial to skill mastery. Continued research is needed to improve instruction in basic skills for vocational education.

REVIEW OF RELATED INSTRUCTION IN ALABAMA TECHNICAL AND COMMUNITY COLLEGES

A review of related instruction in colleges across the State of Alabama was conducted to determine the general status of related instruction for the five programs addressed in the study and to identify ways in which the related instruction program at Calhoun might be improved. A survey of catalogues, phone interviews and visits to several colleges provided an overview of the status and range of related instruction for technical programs across the State. The number of related course offerings varies. Similarities in requirements appear to occur primarily among occupational diploma programs such as welding, cosmetology, cabinet-making, auto mechanics and auto body. These programs generally require a related math course and a communication skills course.

Related math generally includes the fundamentals of arithmetic, including basic operations with whole numbers, decimals, fractions and percents. Common formulas, measurement and metrics are also covered in most basic math courses. This type course ranges in title from vocational math (Bessemer State) to College Math 100 (Wallace State, Dothan). In some schools related math is taught to specific programs and as such becomes a series of similar courses focusing on specific applications. For example, there may be related math for cosmetology and related math for auto mechanics.

Communication Skills for occupational programs generally includes basic grammar and job related skills such as resume preparation, interview skills and letter writing skills. A focus on occupation related vocabulary occurs in some communication skills courses. Communication skills courses are offered on two levels in some colleges. Level II Communications is generally designed for students in associate degree track programs. This type of course is a prerequisite for Technical Report Writing or it may be a technical writing course. Technical Report Writing is required primarily for degree track students in programs such as drafting, electricity, electronics. In some schools it is required at the diploma level. The prerequisite varies from Communication Skills to English Composition. At Shelton State, Technical Writing is a diploma level requirement for electricity, data processing, and drafting. It is also a diploma requirement at Walker State for drafting, data processing and machine shop. All degree track students at Walker State take English 101, 102, and Speech. At Gadsden State College, Technical Report Writing is required in drafting, machine shop, electronics, civil and electrical engineering. However, it is a college level course which follows English 101.

Some schools offer remedial level related skills courses that are prerequisites to the required related communications and math courses. Hobson State offers this sequence for math and communications. Bessemer State and

Shelton State also offer remediation as a prerequisite for students with deficiencies. At Shelton State the remedial course is Reading. Students must read at the 8th grade level on the difficult level of the T.A.B.E. (Test of Adult Basic Education) in order to enroll in Communications or Grammar Review. Grammar Review is a prerequisite for Technical Writing and both courses are diploma requirements for drafting, electricity, data processing, and general clerical.

Remediation is offered in math as well as reading and language in some schools. Walker State offers comprehensive remediation through its Student Support Services program. Students who fall below identified program levels on the ASSET are diagnosed with the T.A.B.E. and must reach specified exit levels on the T.A.B.E. to enroll in related courses and program courses as well if extensive remediation is needed. This program is similar to the remediation program in the Technical Division at Calhoun. Patterson State also offers remediation based on diagnostic testing using the T.A.B.E.

Beyond remediation and basic related math and communications, related instruction in math varies. Several levels of algebra are offered as well as courses in business math, geometry, trigonometry and technical mathematics. There are also numerous shop math courses. These include courses such as math for drafting, math for electricity, and

math for machine shop. The math requirements for programs such as drafting, electricity, electronics, and machine shop vary especially at the diploma level. The content ranges from basic math to trigonometry.

Since Associate Degree requirements can be met concurrently with diploma requirements in some of these programs, related course requirements vary. College English and Technical Writing and college math courses are generally required in community colleges. A comparative view of sample programs illustrates the variations in related instruction requirements. Related requirements for drafting for Southwest Technical College, MacArthur Technical College, Bessemer State, Muscle Shoals State, Gadsden State Community College, Wallace State Community College, Hanceville and Wallace State, Dothan are listed below.

RELATED INSTRUCTION COURSES FOR DRAFTING

Southwest Tech Diploma/Degree 8 Quarters	MacArthur State Tech Certificate/Degree 8 Quarters
MAH 133 Technical Mathematics	RM 111 Algebra I
MAH 134 Technical Mathematics	RM 122 Algebra II
COM 121 Communication Skills	RM 133 Trigonometry
COM 122 Technical Writing	RC 211 Communication Skills
	RC 222 Technical Writing
Bessemer State **Associate Degree** **Day Program**	**Muscle Shoals State** **Associate Degree** **7 Quarters**
RCS Communication Skills I	RC 137 Communication Skills
RCS Communication Skills II	MA 141 Basic Math
RCS Technical Writing	MA 143 Algebra
RMA Algebra I	MA 147 Trigonometry
RMA Algebra II	RM Technical Writing
RMA Trigonometry	

Gadsden State
Diploma (6 quarters)
Civil Drafting Technology

MTH 108 Elementary Algebra
ENG 101 English Composition
MTH 109 College Algebra
MTH 111 Trigonometry
CET 265 Survey Math

Gadsden State
Diploma (7 quarters)
Mechanical Drafting

ENG 101 English Comp.
MTH 100 College Math
MTH 109 College Algebra
ENG Technical Report Writing
MTH 111 Trigonometry

Wallace State (Hanceville)
Diploma
Drafting Technology

DRG 112 Vocational Mathematics

DRG 112 Technical Writing
DRG 122 Applied Algebra

DRG 132 Applied Trigonometry
DRG 142 Applied Descriptive Geometry

Wallace State (Dothan)
Diploma/Degree
Drafting

MTH 109 Intermediate College Algebra
MTH 112 Precalculus Alg.
MTH 113 Precalculus with Trigonometry
ENG 101 English Comp.
ENG 130 Technical Report Writing

Wallace State (Selma) offers a sequence of eight courses called Math of Drafting at the diploma level.

Electricity diploma programs vary in the amount of and type of math requirements. Some programs offer applied math courses which treat algebra and trigonometry in the context of electricity. Shelton State offers fundamental algebra, trigonometry, and geometry for electricians. Wallace State (Dothan) offers Electricity Mathematics and an Electricity Mathematics Lab in the diploma program. J. F. Drake State offers mathematics for the Electrician; Opelika State offers two applied math courses in its industrial electricity program. The electricity program at Muscle Shoals Technical College requires algebra and trigonometry. Hobson State and Wallace State, Hanceville, do not require additional math beyond basic or related for the diploma in electricity.

MacArthur State requires Algebra I, Algebra II and Trigonometry for a degree and Algebra I for a diploma in electricity. The proposed model curriculum for electricity diploma and degree programs will bring about more continuity in related math requirements.

SUMMARY

A communication skills course is offered at every college and two courses are offered in several schools. Communications skills courses generally cover fundamentals of grammar, letter and resume writing, occupation related vocabulary and some related reading. An additional communication skills course is offered in some schools primarily for students in associate degree programs. This course offers more detailed study of grammar in preparation for technical writing and/or English 101.

Technical writing is offered at most schools. Generally, it is only required for associate degree programs. Where it is required for the diploma it is generally required for electronics data processing, drafting and electricity.

Related math courses include basic math, varied levels of algebra, geometry, and trigonometry. In some schools basic math courses are tailored for each of the occupational areas. There are also courses called Technical Mathematics, generally offered on two levels. Technical Mathematics

courses group skills in algebra, geometry, and trigonometry as those skills apply to programs such as drafting, electricity and electronics.

Remediation in basic skills is offered in a few technical programs with entry and exit levels based on T.A.B.E. and/or ASSET scores. Remediation program development is a trend across the State. Collaborative efforts coordinated at the State level would be helpful.

IMPLICATIONS FOR CALHOUN

Calhoun's remediation program, Communications 100 and Math 100 is similar to several programs across the State in that individualized prescriptive instruction is based on diagnosis using the T.A.B.E. The T.A.B.E. test-out level used at Calhoun (12.9 on Difficult Level) is considerably higher than those of other programs. This exit level should be reassessed. A reading component would make the program more viable. Other programs assure minimum reading levels before students exit remediation. ASSET entry levels for programs are used at some schools (Walker, Bessemer) and students are diagnosed for remediation only if their test scores fall below specified levels. A similar arrangement would eliminate unnecessary diagnostic testing at Calhoun.

One Communication Skills course is currently serving all programs in the Technical Division and is designed to prepare degree track students for College English as well as equip terminal students with job related language skills. This dual focus is difficult.

Technical Writing is currently required only for electricity at the diploma level at Calhoun. Technical Report Writing is also an interdivisional degree program requirement for all degree programs except barbering, cosmetology, and welding. The need for two courses in technical writing is questionable.

While Calhoun Technical Division students are grouped for instruction in algebra, geometry and trigonometry (drafting, machine shop, air conditioning/refrigeration), a dual grouping (electricity, electronics) of students for Technical Math I and Technical Math II covers many of the same skills. Most schools offer at least two levels of algebra. Walker State offers a pre-college algebra course as an elective in the diploma program and college algebra in the AAT program with pre-algebra serving as prerequisite for degree students who do not score high enough on the ASSET to enroll in college algebra. There needs to be an assessment of the amount of algebra needed by Technical Division students at Calhoun. Presently, Technical Mathematics I, which is required in the Electricity and Electronics programs, is a higher level of algebra than Math 120 - Introduction to Algebra which is required in the air conditioning/refrigeration and drafting programs. Technical Math II, also required by electricity and electronics, covers trigonometric functions, right triangles and vectors. Math 130, Geometry and Trigonometry, required by the machine shop and drafting programs, deals with angular measures and right triangle problems.

It may be possible to reduce the number of math courses by combining Technical Math I (Math 111) with MAH 120 and Technical Math II (Math 112) with Math 130. Instructors and the related math teacher could determine the viability of such combinations.

SURVEY OF COMMUNICATION AND MATHEMATICS SKILLS

A survey of representatives of businesses and industries which employ personnel in the five (5) occupations addressed in the study was conducted. The purpose of the survey was to determine which skills in mathematics and communications are needed in each of the five (5) occupations and to determine if there is a core of skills needed by all five (5) occupations. The program improvement grant required surveying only three (3) businesses and/or industries for each occupational area. The actual number of businesses and industries surveyed was increased. Thirty-five businesses and industries participated in the project. A listing of participating businesses and industries follows:

PARTICIPATING BUSINESSES AND INDUSTRIES

Boeing Corporation
Huntsville

Teledyne Brown Engineering
Huntsville

McDonnell Douglas Corporation
Huntsville

Magunco, Inc
Toney

Phase IV Systems
Hunstville

Acustar Corporation
Huntsville

Saginaw Division of GM
Decatur

Lynn Layton Chevrolet
Decatur

Johnson's Foreign Car
Decatur

Lakeview Garage
Decatur

Cagle Front End & Tire Center
Decatur

Penney's Salon
Decatur

PARTICIPATING BUSINESSES AND INDUSTRIES (continued)

Prestolite Electric, Inc
Decatur

Engelhard Industries
Huntsville

Onan Corporation
Huntsville

Steelcase Industries
Athens

Marshall Space Flight Center
Huntsville

Wolverine Tube Manufacturing
Decatur

Copeland Corporation
Hartselle

Amoco Chemical Company
Decatur

Monsanto Corporation
Decatur

General Electric
Decatur

3M Corporation
Decatur

Goodyear
Decatur

Changes Salon
Decatur

Castner Knott Salon
Decatur

Lifestyles Family Hair Care
Decatur

Scruples I Salon
Decatur

Scruples II Salon
Decatur

White's Barber Shop
Hartselle

Brenda's Barber Shop
Hartselle

Clemmons Barber Shop
Decatur

Cox Corporation
Madison

National A & R Supply
Huntsville

Watson Service Company
Decatur

SURVEY PARTICIPANTS

Participants from industry were supervisors, plant managers, employee development specialists, training managers and training specialists. Participants from businesses were service managers, owners and/or shop managers.

The businesses and industries were identified by technical division faculty, administrators and the Project Director. The personnel managers of industries were contacted by the Project Director. Personnel managers identified the personnel they felt would be qualified to participate in the Project. Small business owners and managers were contacted by the Project Director.

ADMINISTRATION OF SURVEY

The survey was conducted in small group meetings in which the purposes of the Project were explained and information on course requirements for the vocational programs was shared. Discussions were held following each administration of the survey. Participants shared their perceptions of related skills needs of employees as well as information on their training programs. Follow-up visits were made to some businesses and industries to review training materials and programs.

ANALYSIS OF SURVEY DATA

Narrative summaries report Section B responses and information gained through interviews and discussions with business and industrial personnel. Section C data (checklist of competencies) was analyzed separately for each occupation. The percentage of responses for each skill was

computed based on the total number of responses for each skill. A skill was considered necessary if 50 percent or more of the respondents rated it necessary. A skill was considered significant if rated necessary or desirable by a combined response of 75 percent or greater.

Results were converted to bar graphs which compare the response pattern for each skill. These bar graphs provide a pictorial representation of the data.

DESCRIPTION OF THE INSTRUMENT

The instrument was divided into three (3) sections: Section A asked general questions about the business or industry the respondent represented including the type of business or industry, the personnel function of the respondent, the current number of employees and which of the five (5) kinds of employees addressed in the study were employed by the respondent's business or corporation. Section B was comprised of questions about the types of communication and mathematics skills employees are expected to have and the type of training that would be useful to employees. Section B also asked about the basic skill deficiencies of entry level employees. Section C was comprised of a checklist of 31 communication skills and 40 mathematics competencies which respondents rated in one of three ways: skills could be rated <u>necessary</u>, <u>desirable,</u> or

optional. A necessary skill was defined as an essential skill for job performance. A desirable skill was defined as a skill that may enhance employment, and an optional skill was defined as a skill that would seldom be needed for job performance.

An initial checklist of communication and mathematics skills was developed based on interviews with faculty, a survey of texts used in related instruction classes, course syllabi and classroom observations. The preliminary checklist was rated by faculty in the five (5) programs. The checklist was revised based on input from faculty and administrators.

LIMITATIONS OF THE INSTRUMENT

The checklist of competencies in Section C includes general skills covering basic mathematics, algebra, geometry, and trigonometry as well as some technical math skills. The application of a skill to a specific occupation is not stated. Specific applications would have made the instrument too long and technical. The instrument does not clearly distinguish levels of competency needed in algebra, geometry, and trigonometry. The survey instrument is included in the appendix.

SUMMARY OF DISCUSSIONS WITH BUSINESSES AND INDUSTRY

Discussions with representatives of businesses and industry and responses to questions in Section B of the survey provided a general view of related skills required and desired for optimal performance in the specified occupations. The importance of good communication skills and strong mathematical skills was clearly indicated.

Communication skills are more broadly defined in the work place than they are in technical college communication skills classes. Industry stresses the importance of skills related to team management. Effective interpersonal communication skills which facilitate group planning, problem-solving and decision-making are required. Listening and oral communication skills are essential. Good reasoning skills are needed so that individuals and teams can perform tasks independent of supervision. Employee proficiency in the areas of trouble shooting, problem analysis and problem resolution are developed in on-the-job training.

The ability to read and interpret technical manuals and training materials is essential. In some industries employees participate in the development of training manuals and in the presentation of training. Industry is involved in comprehensive training. Programs such as Zenger-Miller's Working program are used widely. The Working program includes units such as:

1. Listening to understand clearly.
2. Giving feedback.
3. Taking on new assignments.
4. Requesting help.
5. Participating in meetings.

Industry produces much of its own training material. The Saginaw Division of General Motors' Quality Education Program includes courses in Statistical Process Control, Communications, Problem Solving and Principles of Manufacturing. The need for workers to learn new concepts and adapt to change as indicated in the research is supported by local industry.

The need for basic computer literacy was also brought out in discussions with business and industry. Increasingly information is being received and transmitted on computers. There is also an increasing emphasis on statistical process control. Businesses and industries which hire electricians, air conditioning/refrigeration technicians, and mechanics stressed the need for such personnel to have a background in electronics, which in turn necessitates advanced math skills. The trend in industry is toward a reduction in the number of skilled trades personnel. Personnel must be trained in at least two skilled trades to be considered for employment.

Industries and firms which hire drafters emphasized the need for drafters to be able to communicate with engineers. They must be able to locate, read and interpret technical information. Technical vocabulary and familiarity with technical specifications are required.

A high level of proficiency in algebra, geometry, and trigonometry is expected. The importance of geometric tolerancing was also stressed. Writing skills needed by drafters vary among the businesses and industries surveyed. Most indicated that training in technical writing would be helpful to drafting employees. Drafters classified as designers are often required to write reports and develop manuals. Good keyboarding skills were recommended to facilitate the use of CAD systems.

Businesses emphasized the importance of communicating effectively with customers and clients. The ability to describe services, and explain problems and processes is essential. The mastery of basic mathematics skills is essential. A knowledge of geometry was identified as a need for mechanics and a basic knowledge of algebra for air conditioning/refrigeration technicians.

SUMMARY OF SECTION B SURVEY RESPONSES

Section B of the survey asked respondents questions about types of skills that entry level employees lack sufficient competence in; the types of basic skills courses that would be useful to employees; and the types of courses respondents would recommend be offered in vocational programs which train employees in the specified occupations.

All respondents indicated that communication skills should be a part of the vocational training for employees hired by the companies and businesses they represented.

All four communication skills areas (listening, speaking, reading, and writing) are needed for optimal job performance. Respondents indicated that new or entry level employees lack sufficient competence in all four areas. Most respondents indicated that training in oral communications would be helpful to their employees. With the exception of respondents for auto mechanics and cosmetologists, respondents indicated that training in technical writing would be useful to their employees.

Respondents in the skilled trades recommended that courses in basic mathematics, algebra, and geometry and trigonometry should be taught. Computer mathematics was recommended by several respondents from industry. Businesses generally recommended a course in business math.

The major math skill deficiencies of entry level employees in both industry and business were basic math skills and algebra. The application of geometry and trigonometry skills were deficiencies noted for drafting employees.

ANALYSIS OF SURVEY CHECKLIST DATA FOR MECHANICS
(18 Respondents)

COMMUNICATION SKILLS

Two of four listening skills were rated highly necessary: follow directions (100 percent) and interpret and apply oral communications (89 percent). The ability to summarize information was rated desirable by 56 percent and necessary by 39 percent. The ability to take notes was rated desirable by 50 percent and necessary by 33 percent.

All oral communication skills were rated necessary by 50 to 83 percent of the respondents. The ability to explain a process was the skill that was rated most necessary on the job. Eighty-three percent rated this skill necessary and 17 percent rated it desirable. The ability to use standard English was rated necessary by 72 percent and the ability to describe a product or service was rated necessary by 67 percent.

Written communication skills were generally rated desirable. The skills receiving the highest "necessary" ratings were the ability to write an analysis of a problem (56 percent) and the ability to write an explanation of a process (39 percent). Skills involving punctuation, spelling, and grammar and clear sentences were rated desirable by 56 to 67 percent of the respondents. The ability to compose paragraphs, memos, and letters was rated optional by 56 percent. The ability to write simple

proposals and reports was rated necessary by 33 percent and desirable by 39 percent of the respondents. The ability to use formats for technical writing projects and the ability to edit for clarity and correctness were rated optional by 56 and 67 percent.

Reading skills were all rated necessary by high percentages of responses. Comprehending vocabulary related to the trade was rated necessary by 94 percent and reading and interpreting manuals, text, and materials received an 89 percent "necessary" rating. Eighty-eight percent rated reading blueprints necessary.

MATHEMATICS COMPETENCIES

Basic math skills were identified as necessary. Skills related to algebra were generally rated desirable. Some skills involving geometry were rated necessary by 44 to 56 percent of the respondents. Skills rated necessary by more than 60 percent of the respondents were:

Add, subtract, multiply, and divide whole numbers, decimals, and fractions	100%
Round off numbers	89%
Convert from decimals to fractions	83%
Determine percentage, percent (rate) base	75%
Add, subtract, multiply, divide units of measure	89%
Use graphs, charts, scales, and tables	78%
Read gauges, dials, and meters	94%
Convert measures (English to S. I. metric units)	67%
Compute tolerance	63%
Solve problems involving time, weight, distance, quantity, volume and area	61%

Several skills are significant in that the percentages of "desirable" responses and/or "necessary" were above or

near 50 percent. These skills are:

Solve problems involving ratio and proportion	N=56%	D=38%
Use formulas to solve problems	N=44%	D=50%
Solve equations	N=19%	D=69%
Apply order of operations	N=47%	D=47%
Apply laws of exponents	N=17%	D=56%
Identify geometric shapes and lines	N=51%	D=27%
Solve problems involving geometric shapes, angles, lines and points	N=50%	D=28%

The desirability of higher math skills (algebra and geometry) is indicated by the data.

More than 50 percent of the respondents also identified the following skills as necessary or desirable:

Use scientific calculators	N=28%	D=25%
Use computers for computations	N=24%	D=41%
Perform statistical analysis	N=12%	D=44%

SUMMARY

Percentage of response tables and graphs of survey responses for mechanics follow. The data indicate that:

1. Listening and oral communication skills are highly necessary for mechanics.
2. Written communication skills are desirable. The ability to write an analysis of a problem is however necessary.
3. All reading skills on the survey are necessary.
4. Basic math skills are necessary. Algebra skills are desirable.
5. Geometry is necessary.

PERCENTAGE OF RESPONSE TABLE FOR MECHANICS

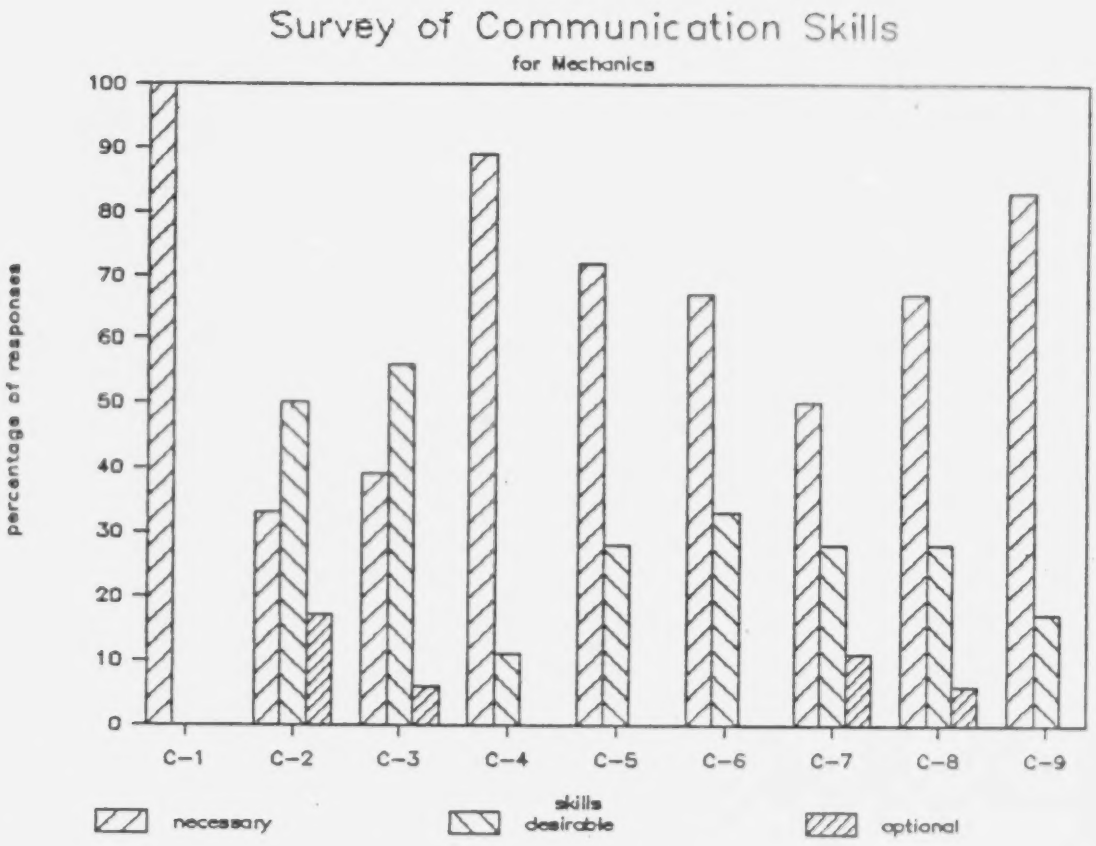
COMMUNICATION SKILLS COMPETENCIES	PERCENTAGE OF RESPONSES		
	NECESSARY	DESIRABLE	OPTIONAL
LISTENING SKILLS			
Follow directions	18/100%	0/0%	0/0%
Take notes	6/33%	9/50%	3/17%
Summarize information	7/39%	10/56%	1/6%
Interpret and apply oral communications	16/89%	2/11%	0/0%
ORAL COMMUNICATIONS			
Use standard English	13/72%	5/28%	0/0%
Speak clearly and precisely	12/67%	6/33%	0/0%
Use appropriate language	9/50%	7/39%	2/11%
Describe a product or service	12/67%	5/28%	1/6%
Explain a process	15/83%	3/17%	0/0%
WRITTEN COMMUNICATIONS			
Punctuate and capitalize correctly	2/11%	10/56%	6/33%
Spell correctly	2/11%	11/61%	5/28%
Apply rules of grammar in written communications	1/6%	12/67%	5/27%
Write clear sentences	5/28%	10/56%	3/17%
Compose paragraphs, memos, letters	2/11%	6/33%	10/56%
Complete applications and business forms	4/22%	9/50%	5/28%
Write a resume	2/11%	5/28%	11/61%
Write a set of instructions	3/17%	9/50%	6/33%
Write a description of a product or mechanism	6/33%	8/44%	4/22%
Write an explanation of a process	7/39%	9/50%	2/11%
Write a technical definition	5/28%	7/39%	6/33%
Write an analysis of a problem	10/56%	4/22%	4/22%
Write simple proposals and reports	6/33%	7/39%	5/28%

COMMUNICATION SKILLS COMPETENCIES	MECHANICS PERCENTAGE OF RESPONSES NECESSARY	DESIRABLE	OPTIONAL
Use acceptable formats for technical writing projects	3/17%	5/28%	10/56%
Edit for clarity and correctness	1/6%	5/28%	12/67%
READING SKILLS			
Read and interpret manuals	16/89%	2/11%	0/0%
Read and interpret text materials	16/89%	2/11%	0/0%
Comprehend vocabulary related to trade	17/94%	1/6%	0/0%
Read and interpret charts, tables, and graphs	15/83%	3/17%	0/0%
Read and interpret technical reports	15/83%	2/11%	1/6%
Read and interpret product information	13/72%	4/22%	1/6%
Read blueprints	16/88%	1/6%	1/6%

MATHEMATICS COMPETENCIES	MECHANICS PERCENTAGE OF RESPONSES NECESSARY	DESIRABLE	OPTIONAL
Add, subtract, mulitply and divide whole numbers, decimals, fractions	18/100%	0/0%	0/0%
Round off numbers	16/89%	2/11%	0/0%
Raise number to a power (cube, square) 16 Responses	7/44%	5/31%	4/25%
Convert from decimals to fractions vice versa	15/83%	3/17%	0/0%
Determine percentage, percent (rate) base 16 Responses	12/75%	3/19%	1/6%
Compute average, mean, mode	7/39%	4/22%	7/39%
Compute simple interest 16 Responses	1/6%	3/19%	12/75%
Determine discount, commission	4/22%	2/11%	12/67%
Determine cost, profit, overhead 16 Responses	2/13%	5/31%	9/56%
Figure payroll and taxes 15 Responses	2/13%	2/13%	11/73%
Solve problems involving ratio and proportions	11/56%	7/38%	1/6%
Use graphs, charts, scales, and tables	14/78%	4/22%	1/6%
Add, subtract, multiply and divide units of measure	16/89%	2/11%	0/0%
Convert measures (English units to S.I. Metric units, vice versa	12/67%	4/22%	2/11%
Solve problems involving time, weight, distance, quantity, volume and area	11/61%	5/28%	2/11%
Perform operations using signed numbers	7/39%	8/44%	3/17%
Read guages, dials, and meters	17/94%	1/6%	0/0%
Compute tolerance 16 Responses	10/63%	5/31%	1/6%
Use measuring instruments such as ruler, protractor, compass, micrometer, caliper	15/83%	3/17%	0/0%
Use formulas to solve problems	8/44%	9/50%	1/6%
Express a problem in terms of mathematical equation	3/17%	11/61%	4/22%
Solve equations 16 Responses	3/19%	11/69%	2/13%
Apply order of operations	8/47%	8/47%	2/6%
Apply laws of exponents	3/17%	10/56%	5/27%
Graph equations	3/17%	6/33%	9/50%
Solve for multi unknowns	3/17%	5/27%	10/56%
Identify geometric shapes and lines	10/56%	5/27%	3/17%
Solve problems involving geometric shapes, angles. lines and points	9/50%	5/28%	4/22%
Solve problems that involve distance	8/44%	5/28%	5/28%
Determine functions of angles	8/44%	7/39%	3/17%

PERCENTAGE OF RESPONSES

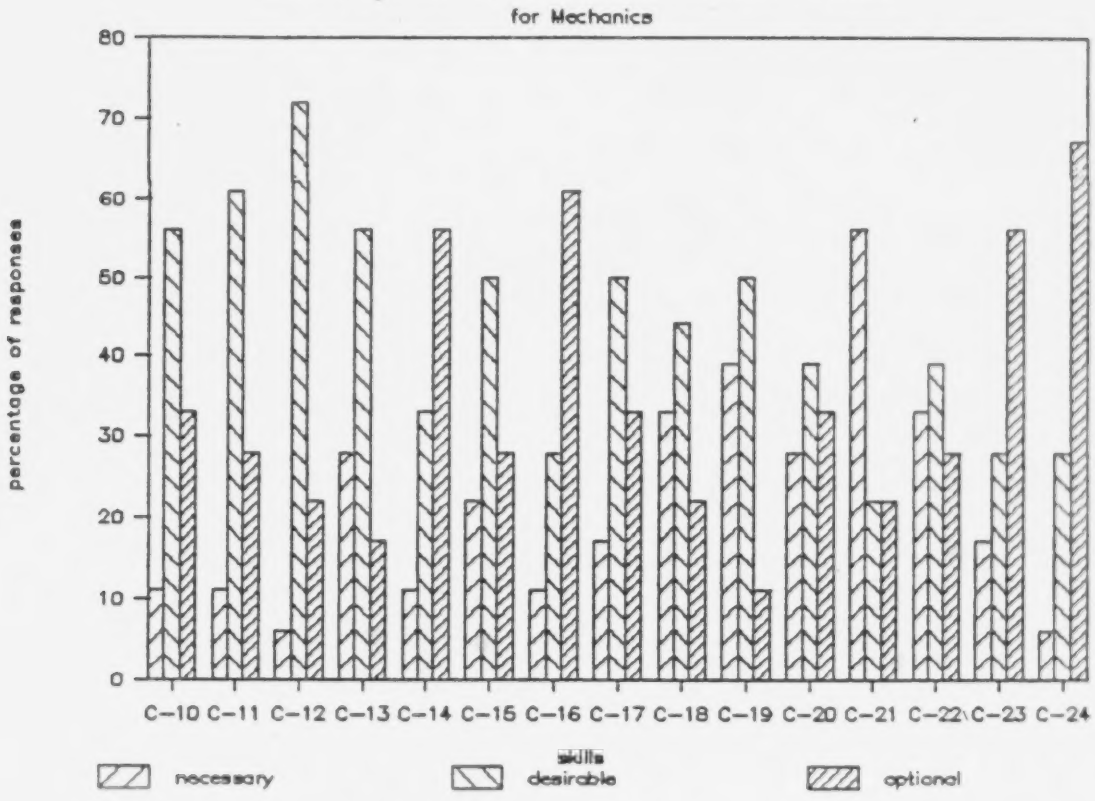
MATHEMATICS COMPETENCIES	NECESSARY	DESIRABLE	OPTIONAL
Use trigometric tables	3/16%	5/28%	10/56%
Solve right triangle problems using sine, cosine, tangent and pythagorean theorem 16 responses	3/19%	4/25%	9/56%
Solve problems involving oblique angles	2/12%	8/44%	8/44%
Apply radian measure to angles	1/6%	7/39%	10/55%
Solve trigometric equations	3/17%	5/28%	10/55%
Graph and chart trigometric results 16 responses	1/6%	5/31%	10/63%
Use scientific calculator 17 responses	5/29%	4/24%	8/47%
Use computer for computations 17 responses	4/24%	7/41%	6/35%
Apply elementary statistics	5/28%	7/39%	6/33%
Perform statistical analysis	2/12%	8/44%	8/44%



COMMUNICATION SKILLS

Listening Skills and Oral Communications

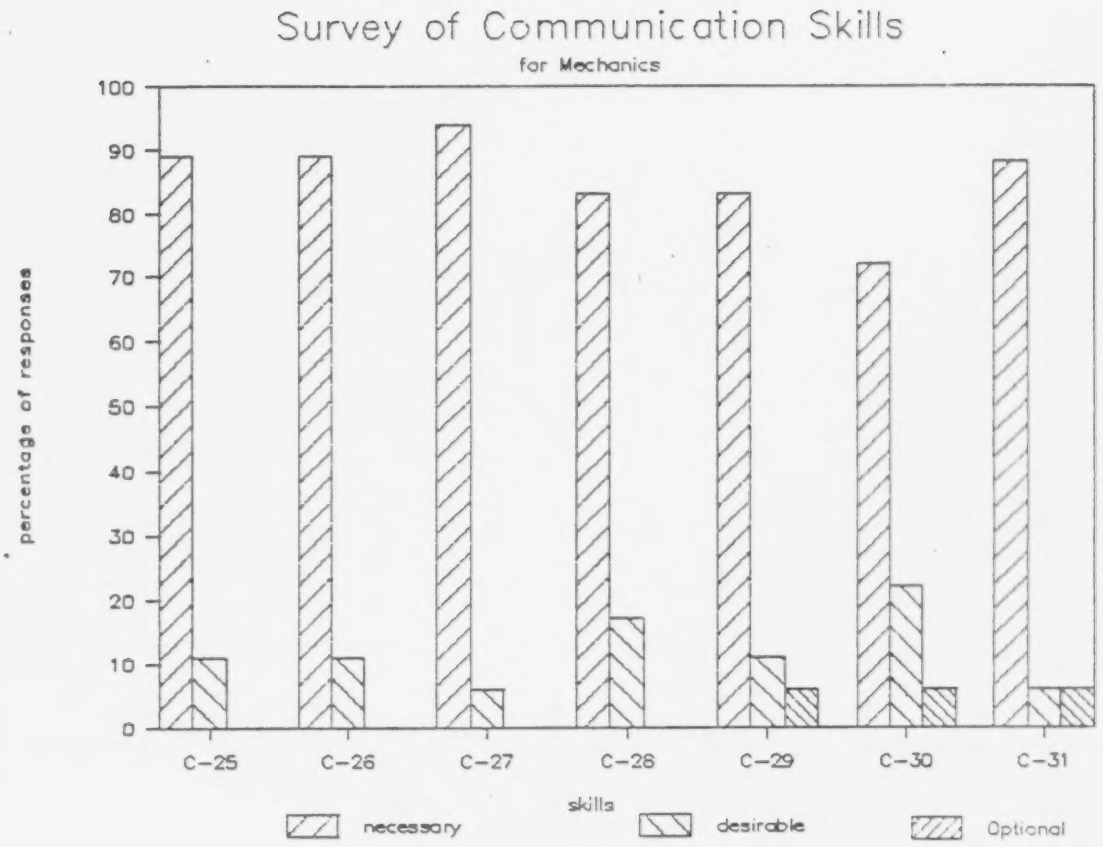
C-1 Follow directions
C-2 Take notes
C-3 Summarize information
C-4 Interpret and apply oral communications
C-5 Use standard English
C-6 Speak clearly and precisely
C-7 Use appropriate language
C-8 Describe a product or service
C-9 Explain a process



COMMUNICATION SKILLS

Written Communications

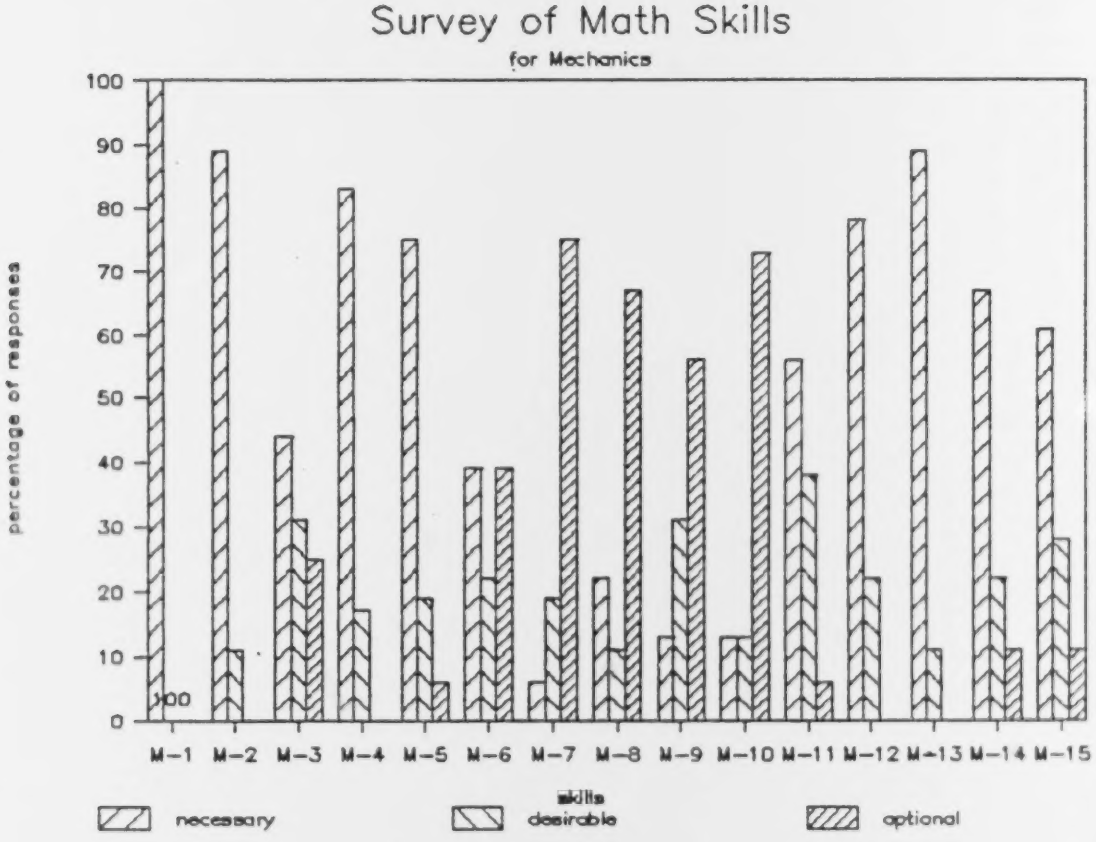
C-10 Punctuate and capitalize correctly
C-11 Spell correctly
C-12 Apply rules of grammar in written communications
C-13 Write clear sentences
C-14 Compose paragraphs, memos, letters
C-15 Complete applications and business forms
C-16 Write a resume
C-17 Write a set of instructions
C-18 Write a description of a product or mechanism
C-19 Write an explanation of a process
C-20 Write a technical definition
C-21 Write an analysis of a problem
C-22 Write simple proposals and reports
C-23 Use acceptable formats for technical writing projects
C-24 Edit for clarity and correctness



COMMUNICATION SKILLS

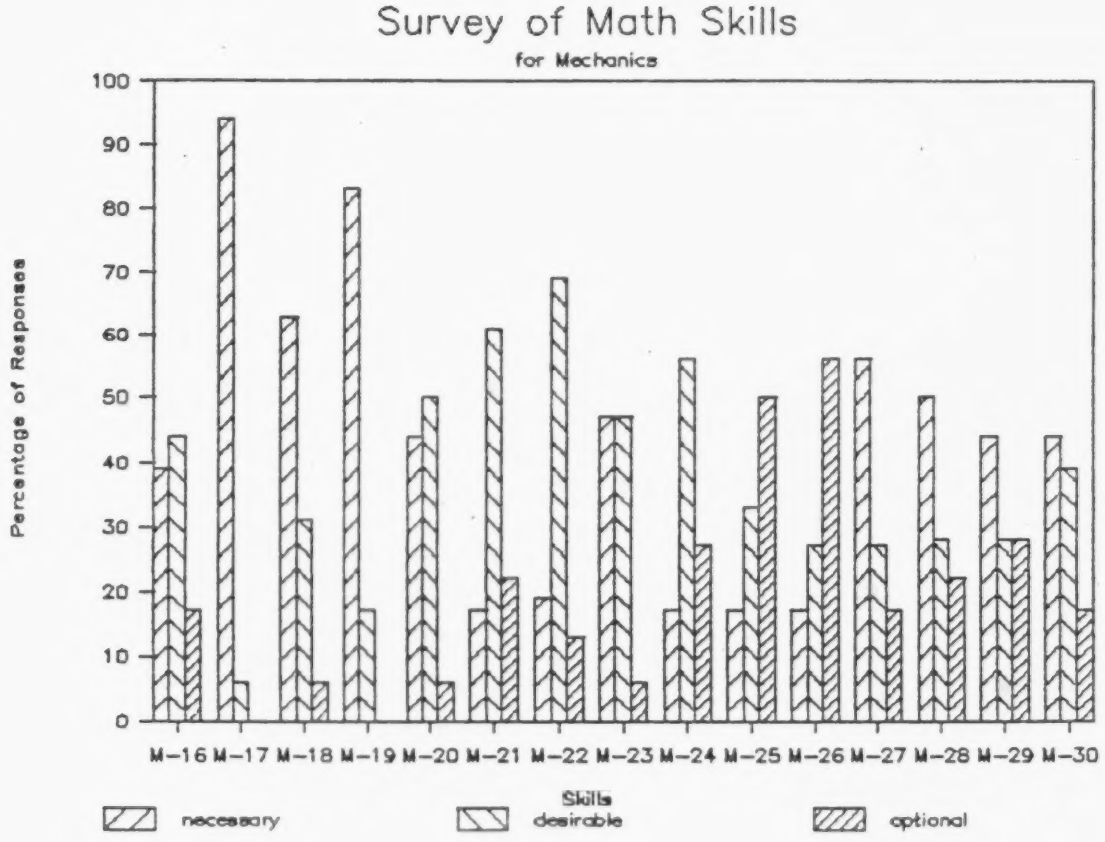
Reading Skills

C-25 Read and interpret manuals
C-26 Read and interpret text materials
C-27 Comprehend vocabulary related to trade
C-28 Read and interpret charts, tables, and graphs
C-29 Read and interpret technical reports
C-30 Read and interpret product information
C-31 Read blueprints



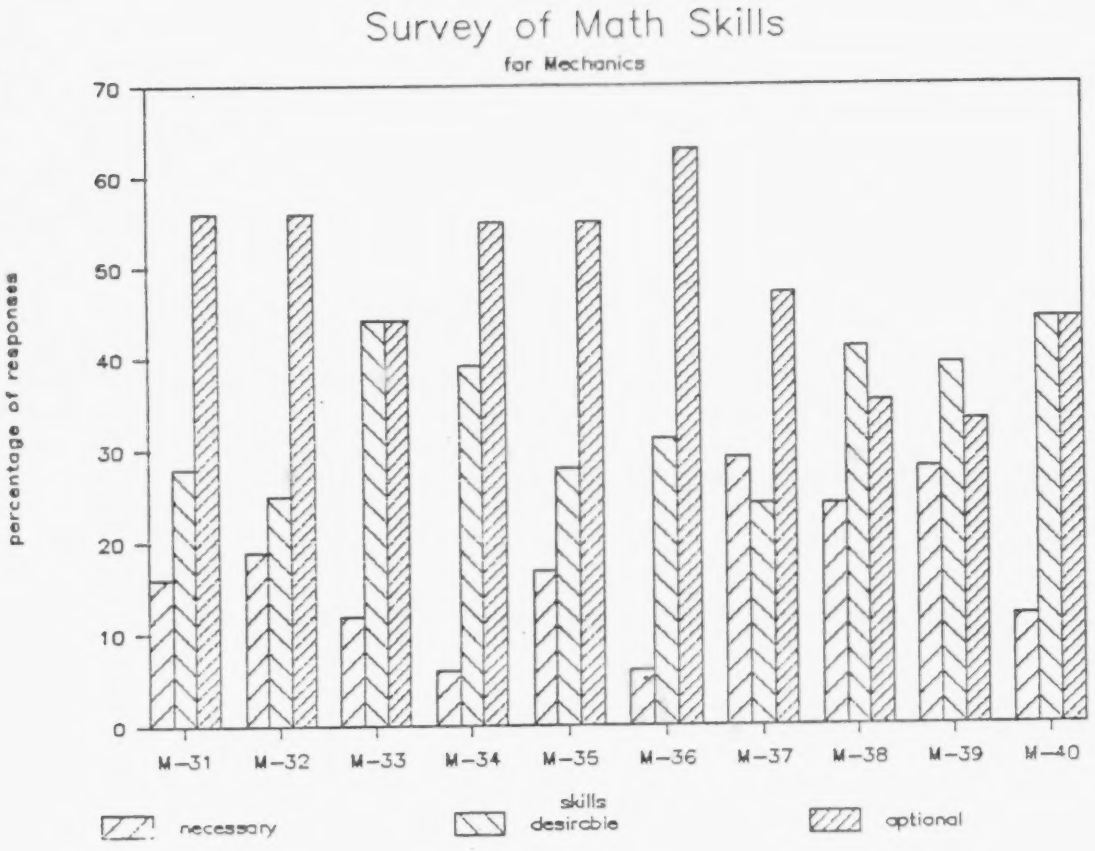
MATHEMATICS
Competencies

M-1	Add, subtract, multiply and divide whole numbers, decimals, and fractions
M-2	Round off numbers
M-3	Raise number to a power (cube, square)
M-4	Convert from decimals to fractions, vice versa
M-5	Determine percentage, percent (rate) base
M-6	Compute average, mean, mode
M-7	Compute simple interest
M-8	Determine discount, commission
M-9	Determine cost, profit, overhead
M-10	Figure payroll and taxes
M-11	Solve problems involving ratio and proportions
M-12	Use graphs, charts, scales and tables
M-13	Add, subtract, multiply and divide units of measure
M-14	Convert measures (English units to S.I. metric units, and vice versa)
M-15	Solve problems involving time, weight, distance, quantity, volume and area



MATHEMATICS
Competencies

M-16 Perform operations using signed numbers
M-17 Read gauges, dials, and meters
M-18 Compute tolerance
M-19 Use measuring instruments such as ruler, protractor, compass, micrometer, caliper
M-20 Use formulas to solve problems
M-21 Express a problem in terms of mathematical equation
M-22 Solve equations
M-23 Apply order of operations
M-24 Apply laws of exponents
M-25 Graph equations
M-26 Solve for multi-unknowns
M-27 Identify geometric shapes and lines
M-28 Solve problems involving geometric shapes, angles, lines, and points
M-29 Solve problems that involve distance
M-30 Determine functions of angles



MATHEMATICS
Competencies

M-31 Use trigonometric tables
M-32 Solve right triangle problems using sine, cosine, tangent and Pythagorean theorem
M-33 Solve problems involving oblique angles
M-34 Apply radian measure to angles
M-35 Solve trigonometric results
M-36 Graph and chart trigonometric results
M-37 Use scientific calculator
M-38 Use computer for computations
M-39 Apply elementary statistics
M-40 Perform statistical analysis

ANALYSIS OF SURVEY CHECKLIST DATA FOR ELECTRICIANS
(16 Survey Respondents)

COMMUNICATION SKILLS

Listening skills were rated necessary. Two of the four listening skills (the ability to take notes and summarize information) were fairly evenly rated as necessary or desirable by 44 to 50 percent and a combined response of 96 percent. The ability to interpret and apply oral communications was rated necessary by 81 percent and the ability to follow directions was rated necessary by 100 percent of the respondents.

All of the oral communication skills were rated necessary by 50 to 81 percent of the respondents. The skill rated necessary by most respondents was the ability to explain a process (81 percent), followed by use of standard English (75 percent).

Written communication skills were generally rated desirable, however, the ability to write an analysis of a problem was rated necessary by 63 percent of the respondents. The ability to write clear sentences was rated necessary by 31 percent and desirable by 63 percent of the respondents. The ability to write a description of a product or mechanism was rated necessary by 44 percent and desirable by 37 percent. The ability to write an explanation of a process was rated necessary by 44 percent and desirable by 44 percent. The ability to write simple

proposals and reports was rated necessary by 31 percent and desirable by 50 percent. The ability to edit for clarity and correctness and the ability to use acceptable formats for technical writing projects were rated optional by more than 50 percent of the respondents.

Reading skills were all rated necessary by 69 to 100 percent. The ability to read and interpret manuals was rated necessary by 100 percent as was the ability to read blueprints.

MATHEMATICS COMPETENCIES

Fifteen math skills were rated necessary by 50 percent or more of the respondents. Basic operations with whole numbers, decimals and fractions, rounding of numbers and reading gauges, dials and meters were rated necessary by 100 percent of the respondents. Using measuring instruments was rated necessary by 94 percent. The other math skills rated necessary were:

Convert decimals to fractions, vice versa	81%
Determine percentages, percent	88%
Solve problems involving ration and proportions	63%
Use graphs scales, tables	75%
Add, subtract, multiply and divide units of measure	88%
Convert measures (English to S. I. metric)	62%
Use formulas to solve problems	63%
Perform operations using signed numbers	50%

Additional algebra, geometry, and trigonometry skills were rated either necessary or desirable by a combined response of 75 percent or more. These skills were:

Express a problem in terms of a mathematical equation	N=31%	D=56%
Solve equations	N=44%	D=50%
Apply order of operations	N=44%	D=50%

Apply laws of exponents	N=0%	D=81%
Identify geometric shapes and lines	N=44%	D=44%
Solve problems involving geometric shapes, angles, lines, and points	N=19%	D=56%
Solve problems that involve distance	N=31%	D=44%
Determine functions of angles	N=24%	D=50%
Use scientific calculator	N=31%	D=44%

SUMMARY

Percentages of response tables and graphs of survey responses for electricians follow. The data indicate that:

1. Listening, oral communications, and reading skills are highly necessary for electricians.

2. Written communication skills are desirable but the most necessary job related writing is writing an analysis of a problem.

3. All of the reading skills on the survey are necessary.

4. Basic math skills are essential. These include measurement, conversion ratio and proportion and the use of graphs, charts, scales and tables.

5. Intermediate and advanced math skills in of algebra, geometry and trigonometry are necessary and/or desirable.

PERCENTAGE OF RESPONSE TABLE FOR ELECTRICIANS

COMMUNICATION SKILLS COMPETENCIES	PERCENTAGE OF RESPONSES		
	NECESSARY	DESIRABLE	OPTIONAL
LISTENING SKILLS			
Follow directions	16/100%	0/0%	0/0%
Take notes	8/50%	7/44%	1/06%
Summarize information	7/44%	8/50%	1/06%
Interpret and apply oral communications	13/81%	3/19%	0/0 %
ORAL COMMUNICATIONS			
Use standard English	12/75 %	4/25%	0/0%
Speak clearly and precisely	11/69 %	5/31%	0/0%
Use appropriate language	8/50 %	7/44 %	1/06 %
Describe a product or service	10/63 %	5/31%	1/06 %
Explain a process	13/81 %	3/19 %	0/0 %
WRITTEN COMMUNICATIONS			
Punctuate and capitalize correctly	0/0 %	10/63 %	6/37%
Spell correctly	1/06 %	10/63 %	5/31 %
Apply rules of grammar in written communications	0/0 %	10/63 %	6/37 %
Write clear sentences	5/31%	10/63 %	1/06 %
Compose paragraphs, memos, letters	0/0 %	8/50 %	8/50 %
Complete applications and business forms	3/19 %	9/56 %	4/25 %
Write a resume	2/13 %	7/44 %	7/44 %
Write a set of instructions	2/13 %	9/56 %	5/31 %
Write a description of a product or mechanism	7/44 %	6/37%	3/19 %
Write an explanation of a process	7/44 %	7/44%	2/12 %
Write a technical definition	6/38 %	5/31%	5/31 %
Write an analysis of a problem	10/63%	4/25%	2/12 %
Write simple proposals and reports	5/31 %	8/50%	3/19 %

ELECTRICIANS

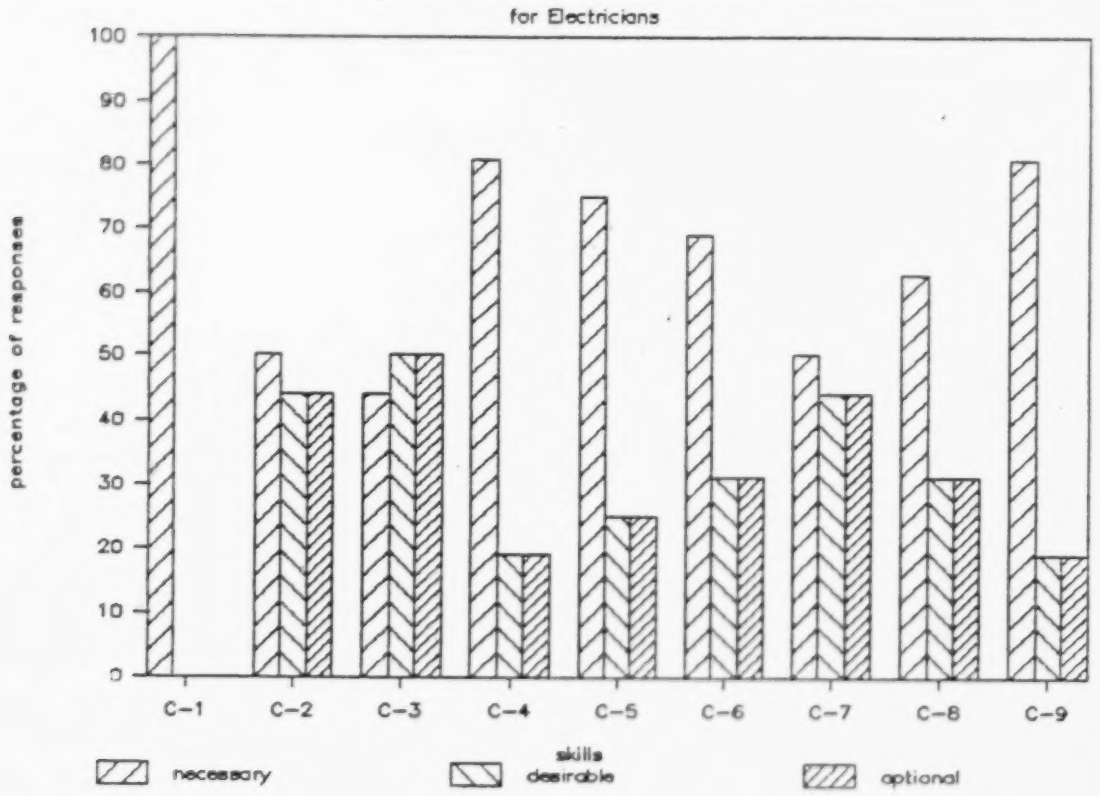
COMMUNICATION SKILLS COMPETENCIES	PERCENTAGE OF RESPONSE		
	NECESSARY	DESIRABLE	OPTIONAL
Use acceptable formats for technical writing projects	4/25%	4/25 %	8/52 %
Edit for clarity and correctness	1/06%	6/37 %	9/56 %
READING SKILLS			
Read and interpret manuals	16/100%	0/0 %	0/0 %
Read and interpret text materials	15/94 %	1/06%	0/0 %
Comprehend vocabulary related to trade	15/94 %	1/06 %	0/0 %
Read and interpret charts, tables, and graphs	15/94 %	1/06 %	0/0 %
Read and interpret technical reports	13/81 %	3/19 %	0/0 %
Read and interpret product information	11/69 %	3/19 %	2/12 %
Read blueprints	16/100%	0/0 %	0/0 %

ELECTRICIANS

MATHEMATICS COMPETENCIES	PERCENTAGE OF RESPONSES		
	NECESSARY	DESIRABLE	OPTIONAL
Add, subtract, mulitply and divide whole numbers, decimals, fractions	16/100%	0/0 %	0/0 %
Round off numbers	16/100%	0/0 %	0/0 %
Raise number to a power (cube, square)	8/50 %	6/37%	11/13%
Convert from decimals to fractions vice versa	13/81 %	3/19%	0/0 %
Determine percentage, percent (rate) base	14/88 %	2/12%	0/0 %
Compute average, mean, mode	8/50 %	4/25%	4/25 %
Compute simple interest	2/12 %	3/19%	11/69 %
Determine discount, commission	3/19 %	2/12%	11/69 %
Determine cost, profit, overhead	1/06 %	7/44%	8/50 %
Figure payroll and taxes	1/06 %	5/31%	10/63 %
Solve problems involving ratio and proportions	10/63 %	5/31%	1/06 %
Use graphs, charts, scales, and tables	12/75 %	4/25 %	0/0 %
Add, subtract, multiply and divide units of measure	14/88 %	2/12%	0/0 %
Convert measures (English units to S.I. Metric units, vice versa	10/62 %	6/38%	0/0 %
Solve problems involving time, weight, distance, quantity, volume and area	6/38%	9/56 %	1/06 %
Perform operations using signed numbers	8/50%	6/38 %	2/12 %
Read guages, dials, and meters	16/100 %	0/0 %	0/0 %
Compute tolerance	11/69 %	5/31%	0/0 %
Use measuring instruments such as ruler, protractor, compass, micrometer, caliper	15/94 %	1/06 %	0/0%
Use formulas to solve problems	10/63 %	5/31%	1/06%
Express a problem in terms of mathematical equation	5/31%	9/56 %	2/13%
Solve equations	7/44%	8/50 %	1/06%
Apply order of operations	7/44%	8/50 %	1/06%
Apply laws of exponents	0 %	13/81 %	3/19%
Graph equations	2/13%	8/50 %	6/38%
Solve for multi unknowns	2/13%	7/44 %	7/44%
Identify geometric shapes and lines	7/44%	7/44 %	2/13%
Solve problems involving geometric shapes, angles, lines and points	3/19%	9/56 %	4/25%
Solve problems that involve distance	5/31%	7/44 %	4/25%
Determine functions of angles	4/25%	8/50 %	4/25 %

ELECTRICIANS
PERCENTAGE OF RESPONSES

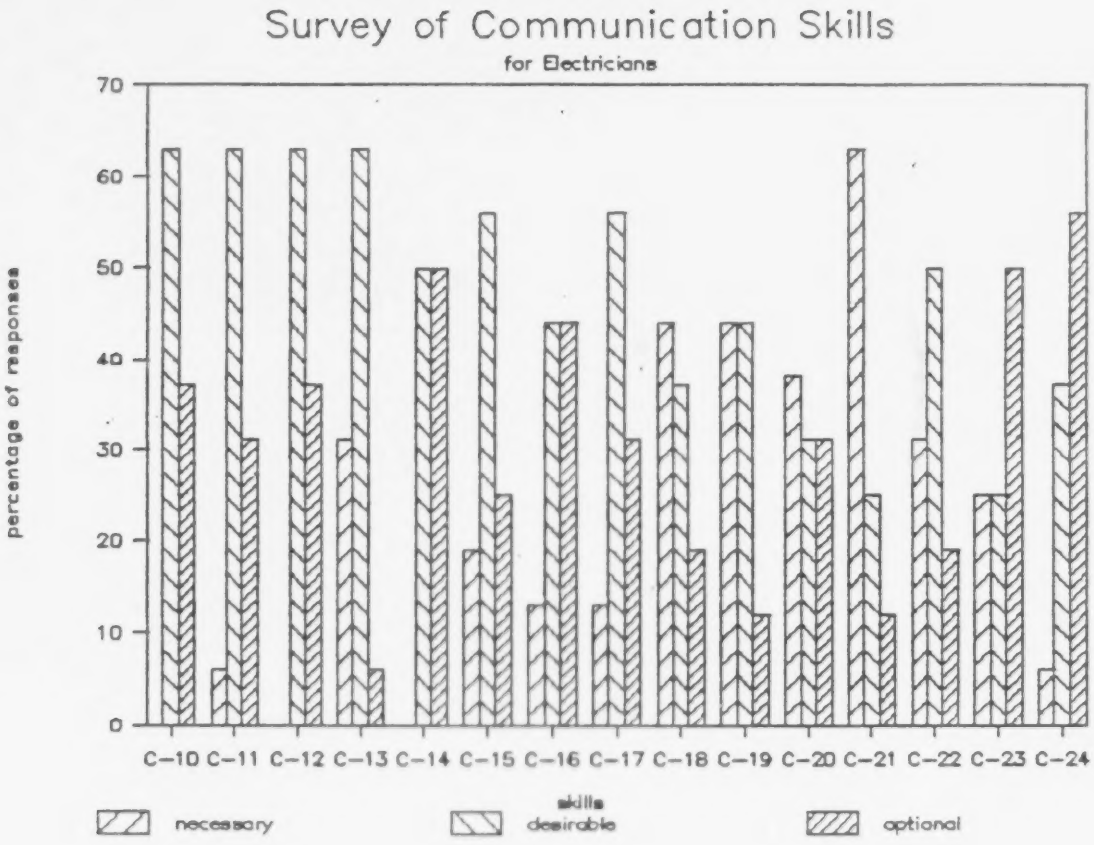
MATHEMATICS COMPETENCIES	NECESSARY	DESIRABLE	OPTIONAL
Use trigometric tables	3/19 %	7/44 %	6/37 %
Solve right triangle problems using sine, cosine, tangent and pythagorean theorem	3/19 %	8/50 %	5/31 %
Solve problems involving oblique angles	3/19 %	8/50 %	5/31 %
Apply radian measure to angles	1/06%	6/38 %	9/56 %
Solve trigometric equations	4/25 %	4/25 %	8/50 %
Graph and chart trigometric results	2/13 %	6/38 %	8/50 %
Use scientific calculator	5/31 %	7/44 %	4/25 %
Use computer for computations	3/19 %	7/44 %	6/37 %
Apply elementary statistics	4/25 %	7/44 %	5/31 %
Perform statistical analysis	2/13 %	8/50%	6/37 %



COMMUNICATION SKILLS

Listening Skills and Oral Communications

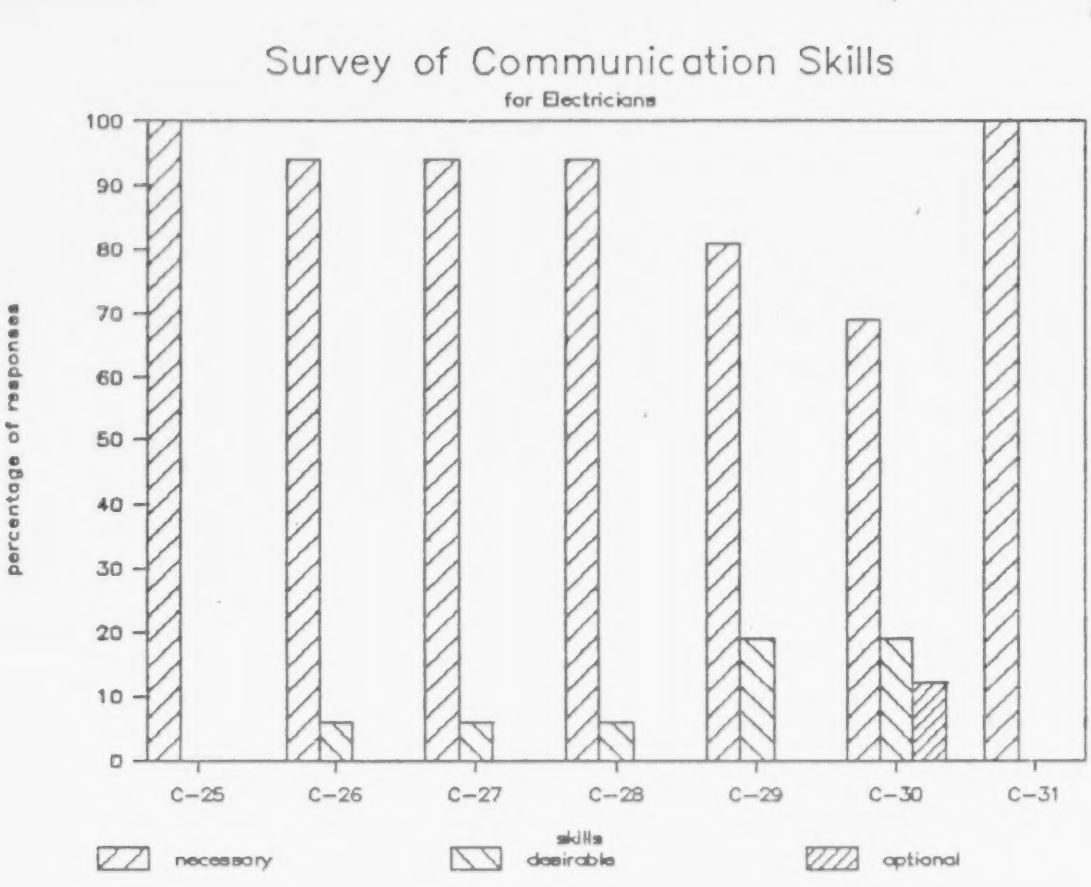
C-1 Follow directions
C-2 Take notes
C-3 Summarize information
C-4 Interpret and apply oral communications
C-5 Use standard English
C-6 Speak clearly and precisely
C-7 Use appropriate language
C-8 Describe a product or service
C-9 Explain a process



COMMUNICATION SKILLS

Written Communications

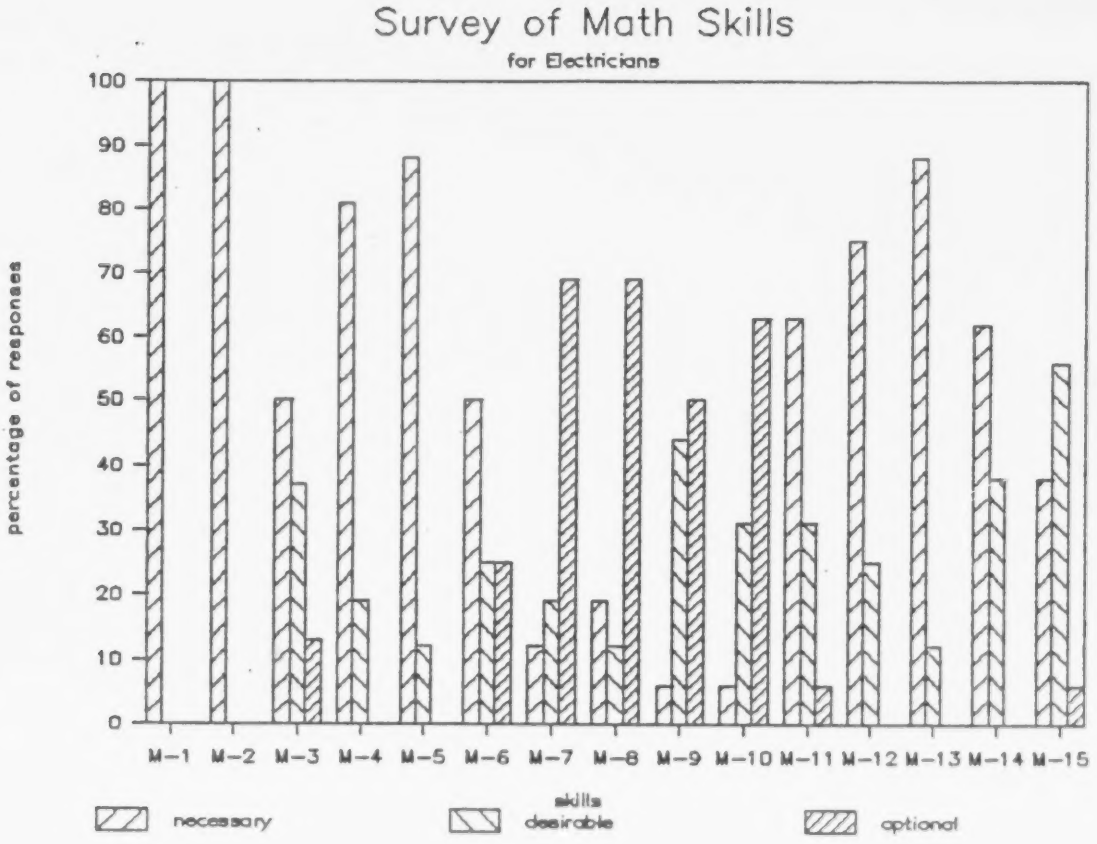
C-10 Punctuate and capitalize correctly
C-11 Spell correctly
C-12 Apply rules of grammar in written communications
C-13 Write clear sentences
C-14 Compose paragraphs, memos, letters
C-15 Complete applications and business forms
C-16 Write a resume
C-17 Write a set of instructions
C-18 Write a description of a product or mechanism
C-19 Write an explanation of a process
C-20 Write a technical definition
C-21 Write an analysis of a problem
C-22 Write simple proposals and reports
C-23 Use acceptable formats for technical writing projects
C-24 Edit for clarity and correctness



COMMUNICATION SKILLS

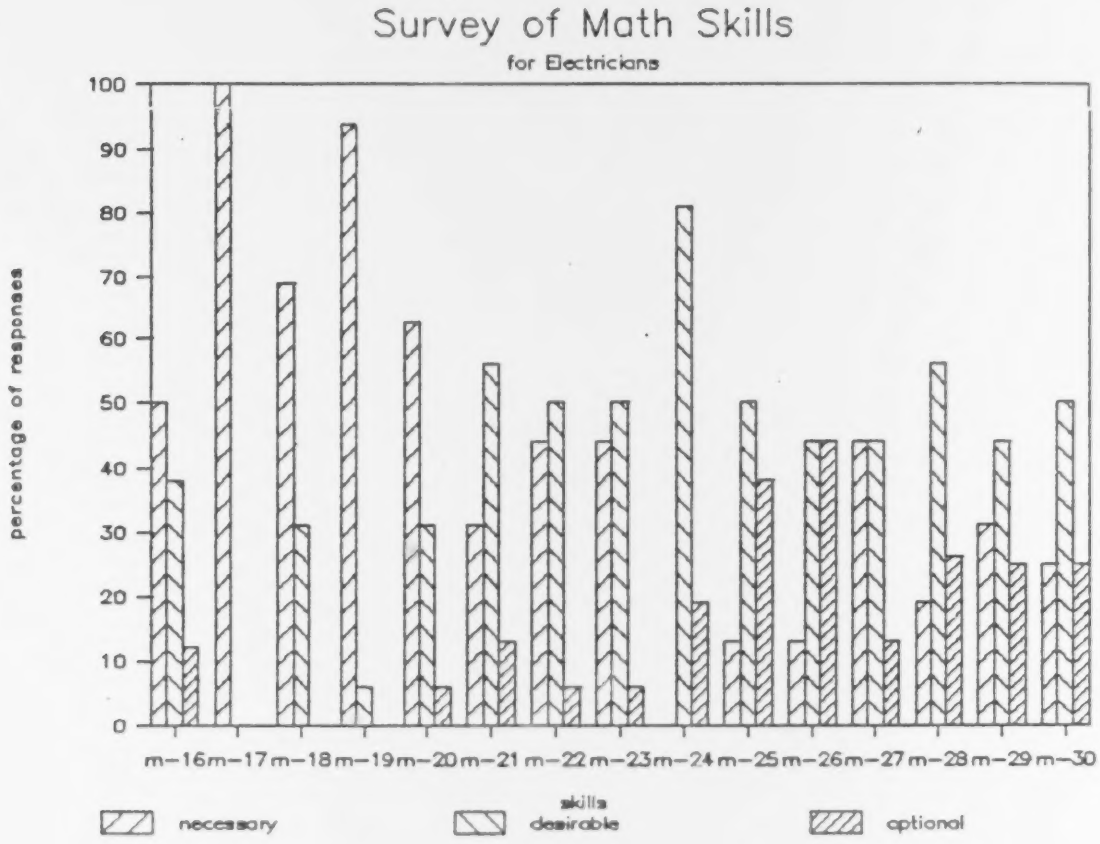
Reading Skills

C-25 Read and interpret manuals
C-26 Read and interpret text materials
C-27 Comprehend vocabulary related to trade
C-28 Read and interpret charts, tables, and graphs
C-29 Read and interpret technical reports
C-30 Read and interpret product information
C-31 Read blueprints



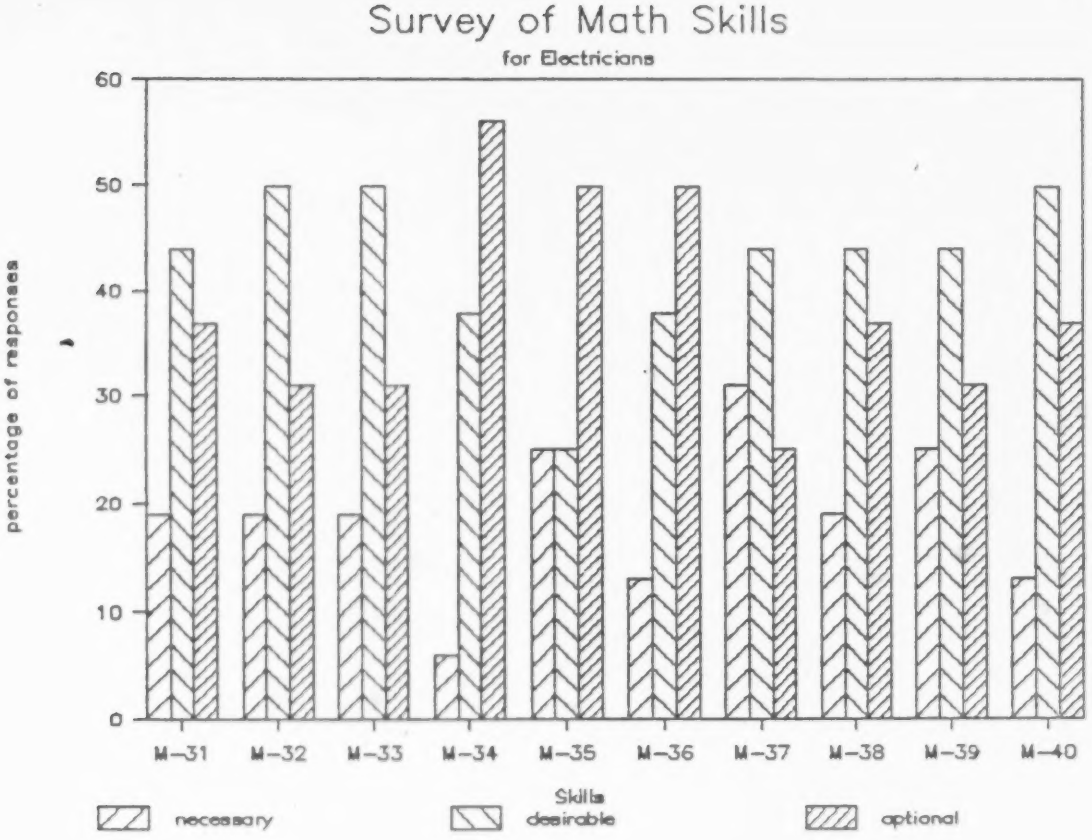
MATHEMATICS
Competencies

M-1	Add, subtract, multiply and divide whole numbers, decimals, and fractions
M-2	Round off numbers
M-3	Raise number to a power (cube, square)
M-4	Convert from decimals to fractions, vice versa
M-5	Determine percentage, percent (rate) base
M-6	Compute average, mean, mode
M-7	Compute simple interest
M-8	Determine discount, commission
M-9	Determine cost, profit, overhead
M-10	Figure payroll and taxes
M-11	Solve problems involving ratio and proportions
M-12	Use graphs, charts, scales and tables
M-13	Add, subtract, multiply and divide units of measure
M-14	Convert measures (English units to S.I. metric units, and vice versa)
M-15	Solve problems involving time, weight, distance, quantity, volume and area



MATHEMATICS
Competencies

M-16 Perform operations using signed numbers
M-17 Read gauges, dials, and meters
M-18 Compute tolerance
M-19 Use measuring instruments such as ruler, protractor, compass, micrometer, caliper
M-20 Use formulas to solve problems
M-21 Express a problem in terms of mathematical equation
M-22 Solve equations
M-23 Apply order of operations
M-24 Apply laws of exponents
M-25 Graph equations
M-26 Solve for multi-unknowns
M-27 Identify geometric shapes and lines
M-28 Solve problems involving geometric shapes, angles, lines, and points
M-29 Solve problems that involve distance
M-30 Determine functions of angles



MATHEMATICS
Competencies

M-31 Use trigonometric tables
M-32 Solve right triangle problems using sine, cosine, tangent and Pythagorean theorem
M-33 Solve problems involving oblique angles
M-34 Apply radian measure to angles
M-35 Solve trigonometric results
M-36 Graph and chart trigonometric results
M-37 Use scientific calculator
M-38 Use computer for computations
M-39 Apply elementary statistics
M-40 Perform statistical analysis

ANALYSIS OF SURVEY CHECKLIST DATA FOR
AIR CONDITIONING/REFRIGERATION TECHNICIANS
(15 Respondents)

COMMUNICATION SKILLS

Two of the four listening skills on the survey were identified as necessary. One hundred percent (100%) of the respondents rated the ability to follow directions "necessary". Eighty percent rated the ability to interpret and apply oral communications "necessary". The ability to take notes and ability to summarize information were rated necessary or desirable by 40 to 53 percent. All oral communication skills on the survey were rated necessary by 63 to 80 percent.

Most written communication skills involving punctuation, spelling and grammar were rated "desirable"; however, several skills were rated necessary or desirable by 40 to 67 percent of the respondents. These skills included writing a description of a product or mechanism, and explanation of a process, a technical definition, simple proposals and reports, and an analysis of a problem as well as using acceptable formats for technical writing projects and editing for clarity and correctness. Forty-seven percent (47%) of the respondents rated editing an optional skill.

All reading skills on the survey were rated necessary by 80 to 100 percent of the respondents with one exception. The ability to read and interpret product information was rated necessary by 67 percent and desirable by 20 percent.

MATHEMATICS COMPETENCIES

Fourteen mathematics competencies were rated necessary by 50 percent or more by the air conditioning/refrigeration respondents. Basic computations, measurement, and problem solving skills comprise most of these necessary skills.

Mathematics Competencies rated necessary by 50 percent or more by the air conditioning/refrigeration respondents were:

Add, subtract, multiply, and divide whole numbers, decimals, and fractions	100%
Round off numbers	93%
Raise numbers to a power	60%
Convert from decimals to fractions (vice versa)	73%
Determine percent (rate) base	87%
Solve problems involving ratio and proportions	73%
Use graphs, charts, scales, and tables	80%
Add, subtract, multiply and divide units of measure	87%
Convert measures (English to S. I. metric)	87%
Solve problems involving time, weight, distance, quantity, volume, and area	73%
Perform operations using signed numbers	53%
Read gauges, dials, and meters	93%
Compute tolerance	87%
Use measuring instruments	93%
Use formulas to solve problems	73%

Several algebra and geometry skills and one business skill were rated desirable and necessary by a combined response above 75 percent. Skills which are significant because of this response pattern follow:

Express a problem in terms of a mathematical equation	N=39%	D=60%
Solve equation	N=46%	D=46%
Apply order of operations	N=46%	D=46%
Identify geometric shapes and lines	N=46%	D=46%
Solve problems involving geometric shapes, angles, lines, and prints	N=20%	D=73%
Determine discount commission	N=27%	D=73%
Compute average, mean, mode	N=47%	D=33%
Determine functions of angles	N=33%	D=47%

It should be noted that representatives of businesses tended to rate business math skills necessary. Representatives of industry did not.

SUMMARY

Percentage of response tables and graphs of survey responses for air condition/refrigeration technicians follow. The data indicate:

1. Listening, oral communication skills and reading skills are necessary.
2. Most written communication skills are desirable. The ability to write an analysis of a problem is necessary. The ability to write a description of a process and the ability to write simple proposals and reports are perceived to be desirable or necessary by most respondents.
3. All reading skills on the survey are necessary.
4. Basic computation skills are necessary.
5. Skills involving measurement, ratio and proportion, use of formulas, charts, graphs, scales, and tables are necessary.
6. Reading gauges, dials, and meters is necessary.
7. Computing tolerance is necessary.
8. Some knowledge of algebra and geometry is necessary.

PERCENTAGE OF RESPONSE TABLE FOR AIR CONDITIONING AND REFRIGERATION TECHNICIANS

COMMUNICATION SKILLS COMPETENCIES	PERCENTAGE OF RESPONSES		
	NECESSARY	DESIRABLE	OPTIONAL
LISTENING SKILLS			
Follow directions	15/100%	0/0 %	0/0 %
Take notes	7/47 %	6/40%	3/20%
Summarize information	7/47 %	8/53%	1/07 %
Interpret and apply oral communications	12/80%	3/20%	0/0 %
ORAL COMMUNICATIONS			
Use standard English	12/80 %	3/20%	0/0 %
Speak clearly and precisely	11/73 %	4/27 %	0/0 %
Use appropriate language	11/73 %	4/27 %	0/0 %
Describe a product or service	11/73 %	3/20 %	1/07%
Explain a process	12/80 %	3/20 %	0/0 %
WRITTEN COMMUNICATIONS			
Punctuate and capitalize correctly	0/0%	11/73 %	4/27%
Spell correctly	3/20%	10/67 %	2/13%
Apply rules of grammar in written communications	0/0%	12/80 %	3/20%
Write clear sentences	4/27%	10/67 %	1/07%
Compose paragraphs, memos, letters	0/0 %	9/60%	6/40%
Complete applications and business forms	4/27 %	8/53%	3/20%
Write a resume	1/07 %	8/53%	6/40 %
Write a set of instructions	2/13 %	10/67%	3/20 %
Write a description of a product or mechanism	6/40 %	7/47 %	2/13 %
Write an explanation of a process	7/47 %	7/47 %	1/07 %
Write a technical definition	6/40%	6/40 %	3/20%
Write an analysis of a problem	8/53%	5/34 %	2/13%
Write simple proposals and reports	7/47%	6/40 %	2/13%

COMMUNICATION SKILLS COMPETENCIES	PERCENTAGE OF RESPONSES NECESSARY	DESIRABLE	OPTIONAL
Use acceptable formats for technical writing projects	4/27 %	7/46%	4/27%
Edit for clarity and correctness	2/13 %	6/40%	7/47 %
READING SKILLS			
Read and interpret manuals	15/100%	0/0%	0/0 %
Read and interpret text materials	13/87 %	2/13%	0/0 %
Comprehend vocabulary related to trade	14/93 %	1/07%	0/0 %
Read and interpret charts, tables, and graphs	14/93 %	1/07%	0/0 %
Read and interpret technical reports	12/80 %	2/13%	1/07 %
Read and interpret product information	10/67 %	3/20%	2/13 %
Read blueprints	14/93 %	1/07%	0/0 %

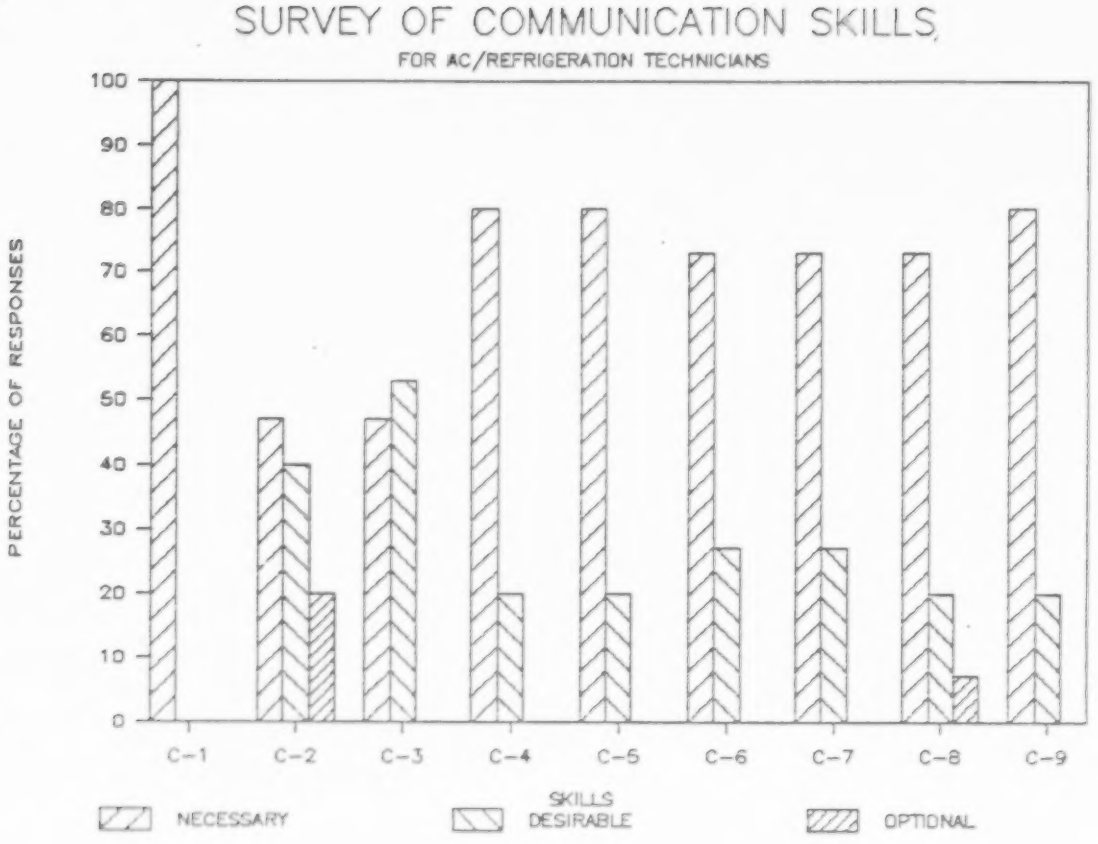
MATHEMATICS

COMPETENCIES

	PERCENTAGE OF RESPONSE		
	NECESSARY	DESIRABLE	OPTIONAL
Add, subtract, mulitply and divide whole numbers, decimals, fractions	15/100%	0/0%	0/0 %
Round off numbers	14/93 %	1/07 %	0/0 %
Raise number to a power (cube, square)	9/60 %	5/33 %	1/07 %
Convert from decimals to fractions vice versa	11/73 %	4/27%	0/0 %
Determine percentage, percent (rate) base	13/87%	2/13 %	0/0 %
Compute average, mean, mode	7/47 %	5/33 %	3/20 %
Compute simple interest	5/33 %	2/13 %	8/53 %
Determine discount, commission	4/27 %	11/73%	0/0 %
Determine cost, profit, overhead	4/27 %	4/27 %	7/46 %
Figure payroll and taxes	4/27 %	3/20 %	8/53 %
Solve problems involving ratio and proportions	11/73 %	3/20 %	1/07 %
Use graphs, charts, scales, and tables	12/80%	3/20%	0/0 %
Add, subtract, multiply and divide units of measure	13/87%	2/13%	0/0 %
Convert measures (English units to S.I. Metric units, vice versa	10/67%	5/33%	0/0 %
Solve problems involving time, weight, distance, quantity, volume and area	11/73%	4/27%	0/0 %
Perform operations using signed numbers	8/53 %	6/40%	1/07 %
Read guages, dials, and meters	14/93%	1/07%	0/0%
Compute tolerance	13/87%	2/13%	0/0%
Use measuring instruments such as ruler, protractor, compass, micrometer, caliper	14/93%	1/07%	0/0%
Use formulas to solve problems	11/73%	4/27%	0/0%
Express a problem in terms of mathematical equation	5/33%	9/60%	1/07%
Solve equations	7/46%	7/46%	1/07%
Apply order of operations	7/46%	7/46%	1/07%
Apply laws of exponents	2/13 %	10/67 %	3/20%
Graph equations	5/33 %	5/33%	5/33 %
Solve for multi unknowns	3/20 %	7/47%	5/33%
Identify geometric shapes and lines	7/46 %	7/46 %	1/07 %
Solve problems involving geometric shapes, angles, lines and points	3/20%	11/73%	1/07%
Solve problems that involve distance	5/33%	6/40%	4/27%
Determine functions of angles	5/33%	7/47%	3/20%

A/C REFRIG. TECHNICIANS

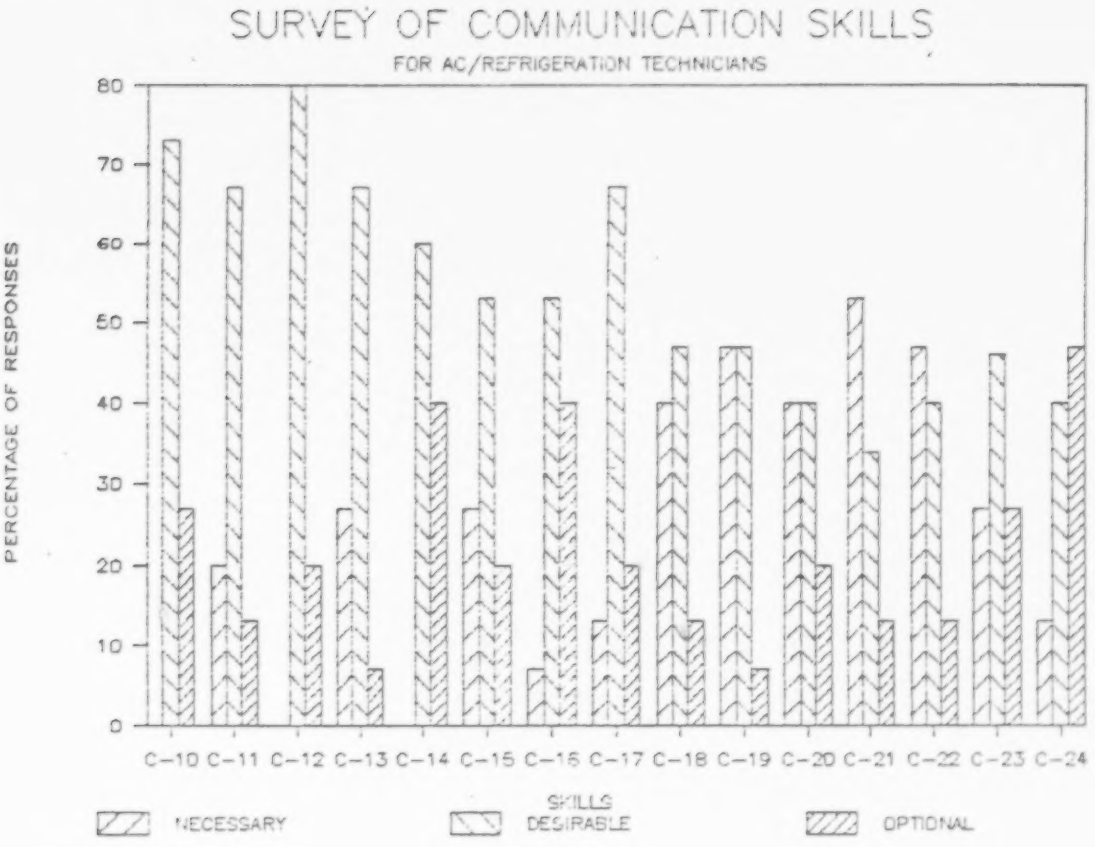
MATHEMATICS COMPETENCIES	PERCENTAGE OF RESPONSES NECESSARY	DESIRABLE	OPTIONAL
Use trigometric tables	2/13%	8/53 %	5/33%
Solve right triangle problems using sine, cosine, tangent and pythagorean theorem	3/20%	7/47 %	5/33%
Solve problems involving oblique angles	1/07%	9/60 %	5/33%
Apply radian measure to angles	1/07%	8/54 %	6/40%
Solve trigometric equations	3/20%	6/40 %	6/40%
Graph and chart trigometric results	3/20%	6/40 %	6/40%
Use scientific calculator	5/33%	6/40 %	4/27%
Use computer for computations	2/13%	9/60 %	4/27%
Apply elementary statistics	4/27%	6/40 %	5/33%
Perform statistical analysis	4/27%	5/33 %	6/40%



COMMUNICATION SKILLS

Listening Skills and Oral Communications

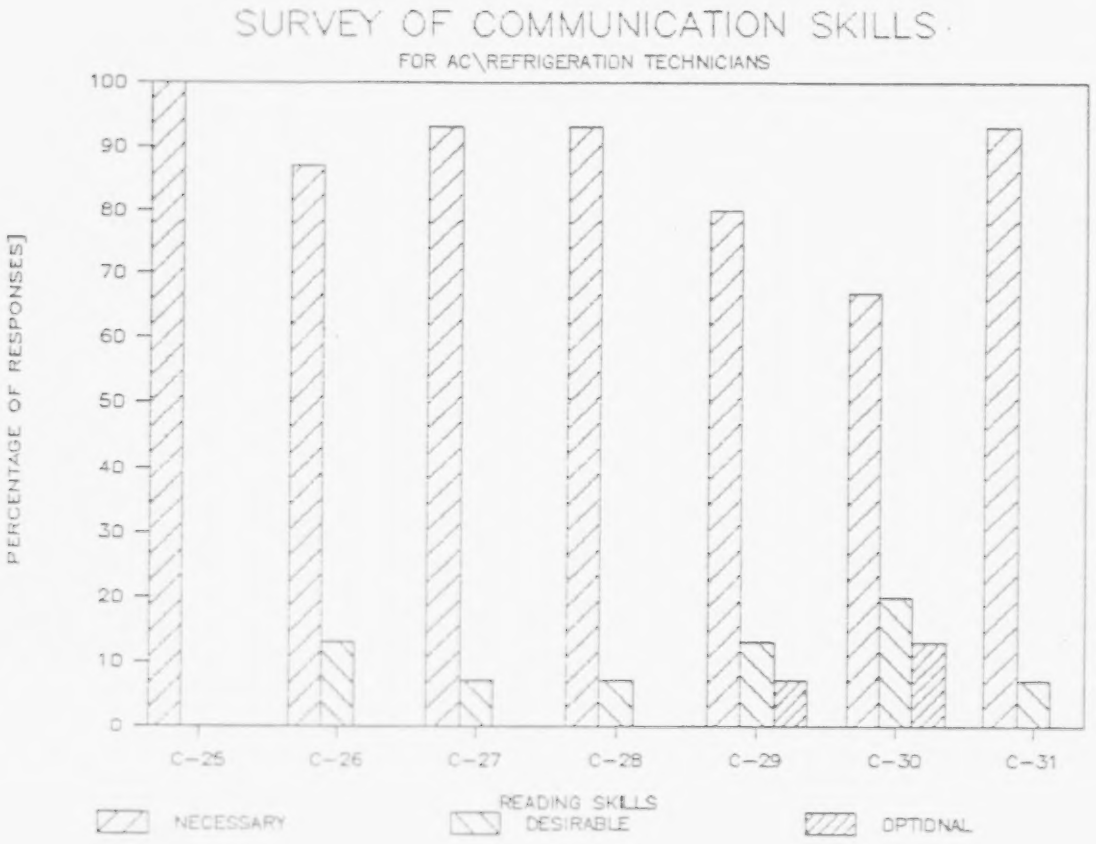
C-1 Follow directions
C-2 Take notes
C-3 Summarize information
C-4 Interpret and apply oral communications
C-5 Use standard English
C-6 Speak clearly and precisely
C-7 Use appropriate language
C-8 Describe a product or service
C-9 Explain a process



COMMUNICATION SKILLS

Written Communications

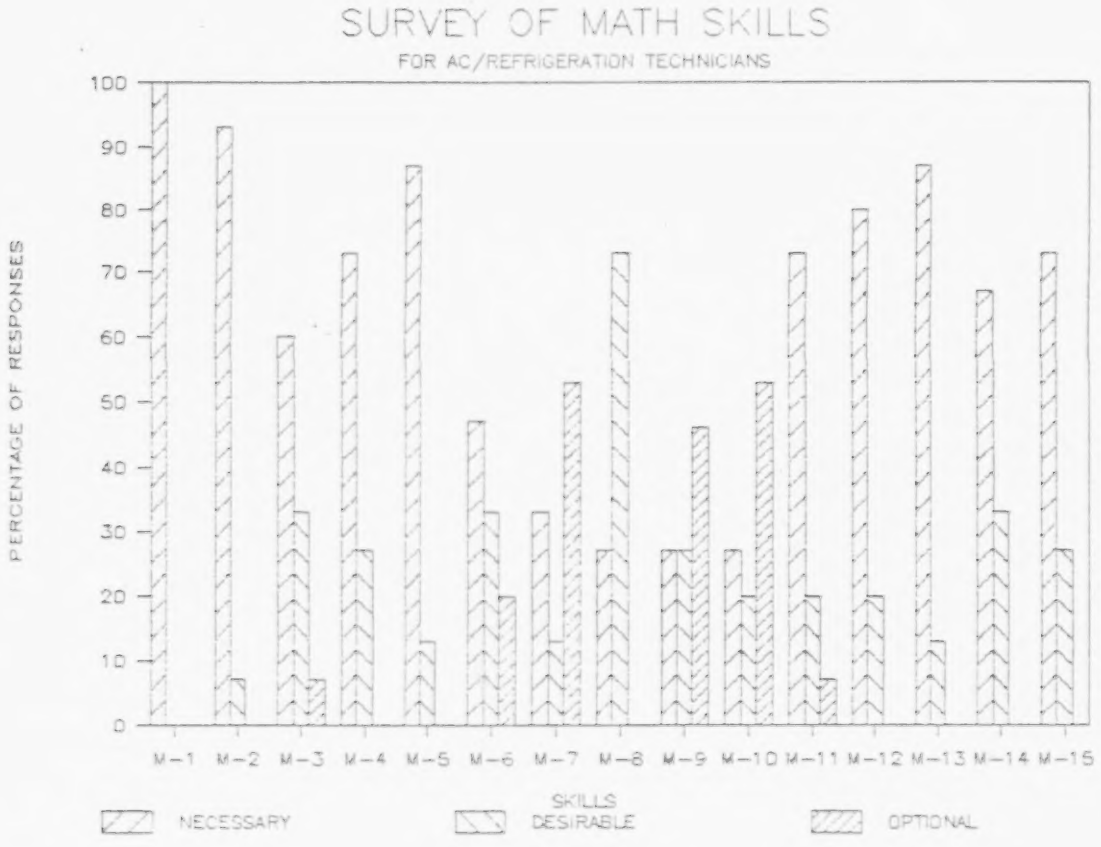
C-10 Punctuate and capitalize correctly
C-11 Spell correctly
C-12 Apply rules of grammar in written communications
C-13 Write clear sentences
C-14 Compose paragraphs, memos, letters
C-15 Complete applications and business forms
C-16 Write a resume
C-17 Write a set of instructions
C-18 Write a description of a product or mechanism
C-19 Write an explanation of a process
C-20 Write a technical definition
C-21 Write an analysis of a problem
C-22 Write simple proposals and reports
C-23 Use acceptable formats for technical writing projects
C-24 Edit for clarity and correctness



COMMUNICATION SKILLS

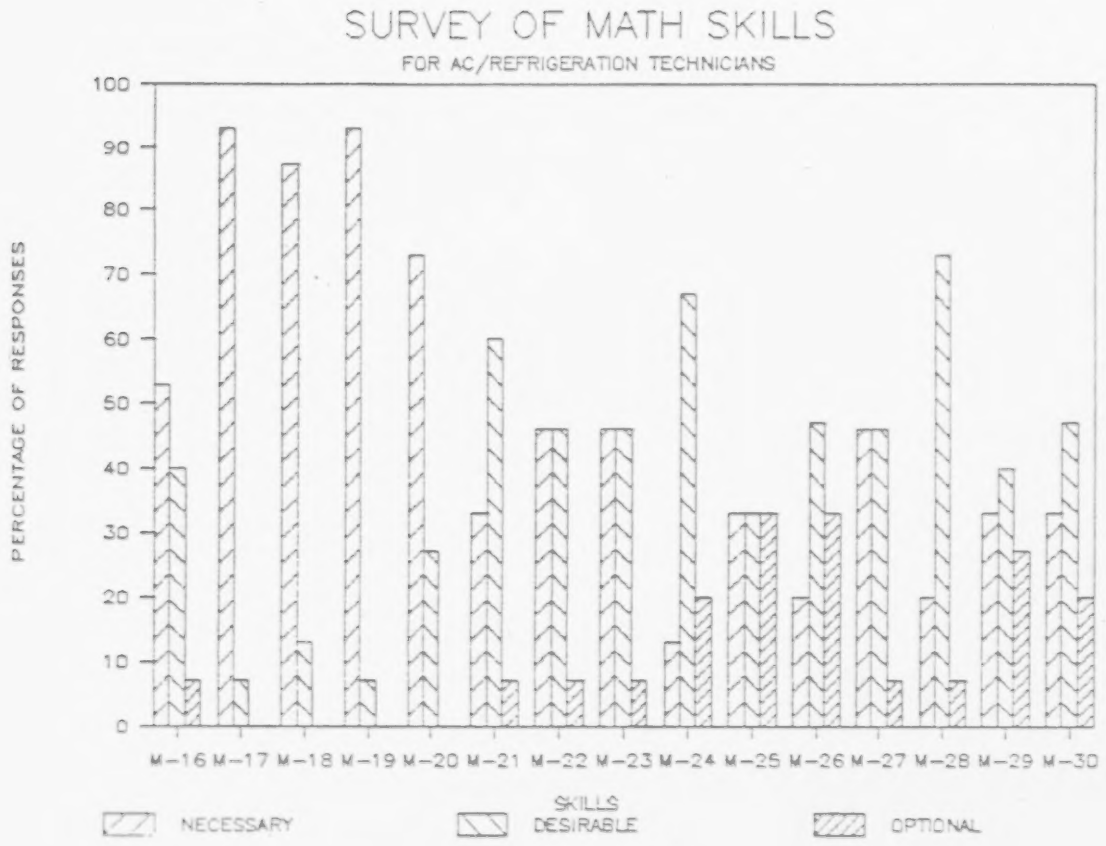
Reading Skills

C-25 Read and interpret manuals
C-26 Read and interpret text materials
C-27 Comprehend vocabulary related to trade
C-28 Read and interpret charts, tables, and graphs
C-29 Read and interpret technical reports
C-30 Read and interpret product information
C-31 Read blueprints



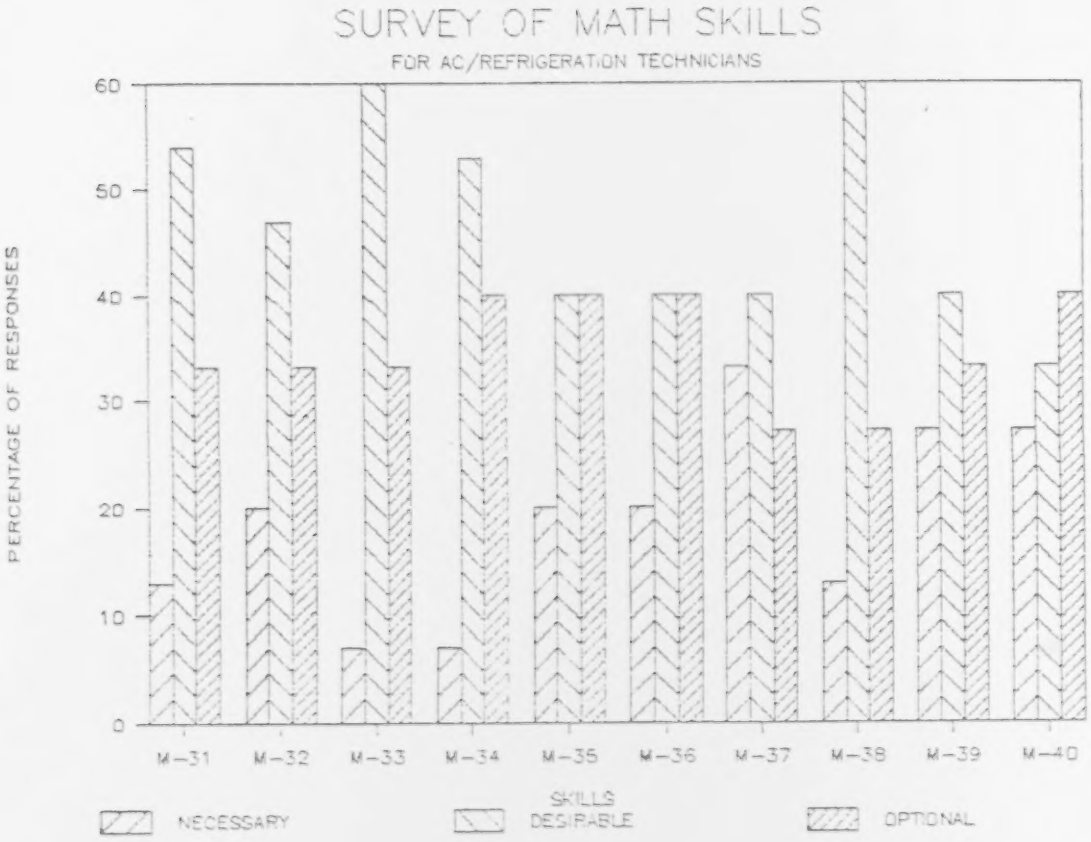
MATHEMATICS
Competencies

M-1	Add, subtract, multiply and divide whole numbers, decimals, and fractions
M-2	Round off numbers
M-3	Raise number to a power (cube, square)
M-4	Convert from decimals to fractions, vice versa
M-5	Determine percentage, percent (rate) base
M-6	Compute average, mean, mode
M-7	Compute simple interest
M-8	Determine discount, commission
M-9	Determine cost, profit, overhead
M-10	Figure payroll and taxes
M-11	Solve problems involving ratio and proportions
M-12	Use graphs, charts, scales and tables
M-13	Add, subtract, multiply and divide units of measure
M-14	Convert measures (English units to S.I. metric units, and vice versa)
M-15	Solve problems involving time, weight, distance, quantity, volume and area



MATHEMATICS
Competencies

M-16 Perform operations using signed numbers
M-17 Read gauges, dials, and meters
M-18 Compute tolerance
M-19 Use measuring instruments such as ruler, protractor, compass, micrometer, caliper
M-20 Use formulas to solve problems
M-21 Express a problem in terms of mathematical equation
M-22 Solve equations
M-23 Apply order of operations
M-24 Apply laws of exponents
M-25 Graph equations
M-26 Solve for multi-unknowns
M-27 Identify geometric shapes and lines
M-28 Solve problems involving geometric shapes, angles, lines, and points
M-29 Solve problems that involve distance
M-30 Determine functions of angles



MATHEMATICS
Competencies

M-31 Use trigonometric tables
M-32 Solve right triangle problems using sine, cosine, tangent and Pythagorean theorem
M-33 Solve problems involving oblique angles
M-34 Apply radian measure to angles
M-35 Solve trigonometric results
M-36 Graph and chart trigonometric results
M-37 Use scientific calculator
M-38 Use computer for computations
M-39 Apply elementary statistics
M-40 Perform statistical analysis

ANALYSIS OF SURVEY CHECKLIST DATA FOR DRAFTERS
(14 Respondents)

COMMUNICATION SKILLS

Three of four listening skills were rated necessary by 50 to 100 percent of the respondents. The ability to summarize information was rated desirable by 64 percent and necessary by 22 percent.

All oral communication skills were rated necessary by 64 percent to 93 percent of the respondents. Use of standard English was rated necessary by the highest percentage of respondents. Speaking clearly and precisely and explaining a process were rated necessary by 71 percent.

Written communication skills were rated desirable. The ability to write clear sentences was rated necessary by 43 percent and desirable by 57 percent. Other skills are significant in that the total percentage of necessary and desirable responses equalled 75 percent or above.

These skills were:

Punctuate and capitalize correctly	N=14%	D=64%
Spell Correctly	N=36%	D=57%
Apply rules of grammar	N=22%	D=71%
Write a desciption of a product or mechanism	N=29%	D=64%
Write an explanation of a process	N=21%	D=65%
Write simple proposals and reports	N=21%	D=57%

Using acceptable formats for technical writing projects was rated optional by 64 percent and editing was rated optional by 36 percent, desirable by 43 percent, and necessary by 21 percent.

All reading skills were rated necessary by 64 to 100 percent of the respondents. The ability to read and interpret text materials and the ability to read blueprints were rated necessary by 100 percent of the respondents.

MATHEMATICS COMPETENCIES

Twenty-three mathematics competencies were rated necessary by 50 to 100 percent of the respondents. These skills were:

Add, subtract, multiply and divide whole numbers, decimals, fractions	100%
Round off numbers	100%
Raise number to a power	64%
Convert from decimals to fractions	86%
Determine percentage, percent (rate) base	79%
Compute average mean, mode	57%
Solve problems involving ratio and proportions	50%
Use graphs, charts, scales, tables	57%
Add, subtract, multiply, and divide units of measure	93%
Convert measures (English to S. I. Metric)	79%
Solve problems involving time, weight, distance, quantity, volume, area	50%
Read gauges, dials, meters	50%
Compute tolerance	64%
Use measuring instruments	79%
Use formulas to solve problems	57%
Identify geometric shapes and lines	71%
Solve problems involving geometric shapes, angles, lines, points	71%
Determine functions of angles	57%
Solve right triangle problems using sine, cosine, tangent and Pythagorean theorem	57%
Solve problems involving oblique angles	50%
Solve trigonometric equations	50%
Use scientific calculator	50%

Some mathematics competencies are significant because they were rated necessary or desirable by a combined percentage of 70 or higher. These skills were:

Express a problem in terms of mathematical equation	N=36%	D=50%
Solve equations	N=43%	D=43%
Apply order of operations	N=36%	D=36%

Use trigonometric tables	N=43%	D=28%
Apply radian measure to angles	N=43%	D=43%
Use computer for computations	N=21%	D=64%

SUMMARY

Percentage of response tables and graphs of survey responses follow. The data indicate that:

1. Listening and oral communication skills are necessary.

2. Written communication skills are desirable. Writing clear sentences, the ability to punctuate and capitalize correctly, and the ability to apply rules of grammar in written communication as well as the ability to write a description of a product or mechanism and an explanation of a process are the most significant writing skills for drafters.

3. All reading skills on the survey are necessary.

4. Advanced mathematics skills in algebra, geometry and trigonometry are necessary.

PERCENTAGE OF RESPONSE TABLE FOR DRAFTERS

COMMUNICATION SKILLS COMPETENCIES	PERCENTAGE OF RESPONSES NECESSARY	DESIRABLE	OPTIONAL
LISTENING SKILLS			
Follow directions	13/93%	0/0%	1/07 %
Take notes	7/50%	7/50%	0/0%
Summarize information	3/22%	9/64 %	2/14%
Interpret and apply oral communications	14/100 %	0/0 %	0/0 %
ORAL COMMUNICATIONS			
Use standard English	13/93 %	1/07 %	0/0 %
Speak clearly and precisely	11/79 %	3/21 %	0/0 %
Use appropriate language	10/71 %	4/29 %	0/0 %
Describe a product or service	7/64 %	3/36 %	0/0 %
Explain a process	11/79 %	2/14 %	1/7 %
WRITTEN COMMUNICATIONS			
Punctuate and capitalize correctly	2/14 %	9/64 %	3/22 %
Spell correctly	5/36 %	8/57 %	1/07 %
Apply rules of grammar in written communications	3/22 %	10/71 %	1/07 %
Write clear sentences	6/43 %	8/57 %	0/0 %
Compose paragraphs, memos, letters	2/14 %	8/57 %	4/29 %
Complete applications and business forms	5/36 %	6/43 %	3/21 %
Write a resume	3/21 %	6/43 %	5/36 %
Write a set of instructions	4/29 %	7/50 %	3/21 %
Write a description of a product or mechanism	4/29 %	9/64 %	1/07 %
Write an explanation of a process	3/21 %	9/65 %	2/14 %
Write a technical definition	3/21 %	7/50 %	4/29 %
Write an analysis of a problem	4/29 %	3/21 %	7/50 %
Write simple proposals and reports	3/21 %	8/57 %	3/21 %

DRAFTERS

PERCENTAGE OF RESPONSES

COMMUNICATION SKILLS COMPETENCIES	NECESSARY	DESIRABLE	OPTIONAL
Use acceptable formats for technical writing projects	2/ 14 %	3/21%	9/ 64 %
Edit for clarity and correctness	3/ 21 %	6/43%	5/ 36 %
READING SKILLS			
Read and interpret manuals	12/ 86%	2 /14%	0/0 %
Read and interpret text materials	14/100%	0/0 %	0/0 %
Comprehend vocabulary related to trade	13/93%	1/ 07%	0/0 %
Read and interpret charts, tables, and graphs	11/79%	2 /14%	1/07%
Read and interpret technical reports	9 /64 %	3/ 21%	2/14%
Read and interpret product information	7 /50 %	6/ 43%	1/07%
Read blueprints	14/100%	0/0 %	0/0 %

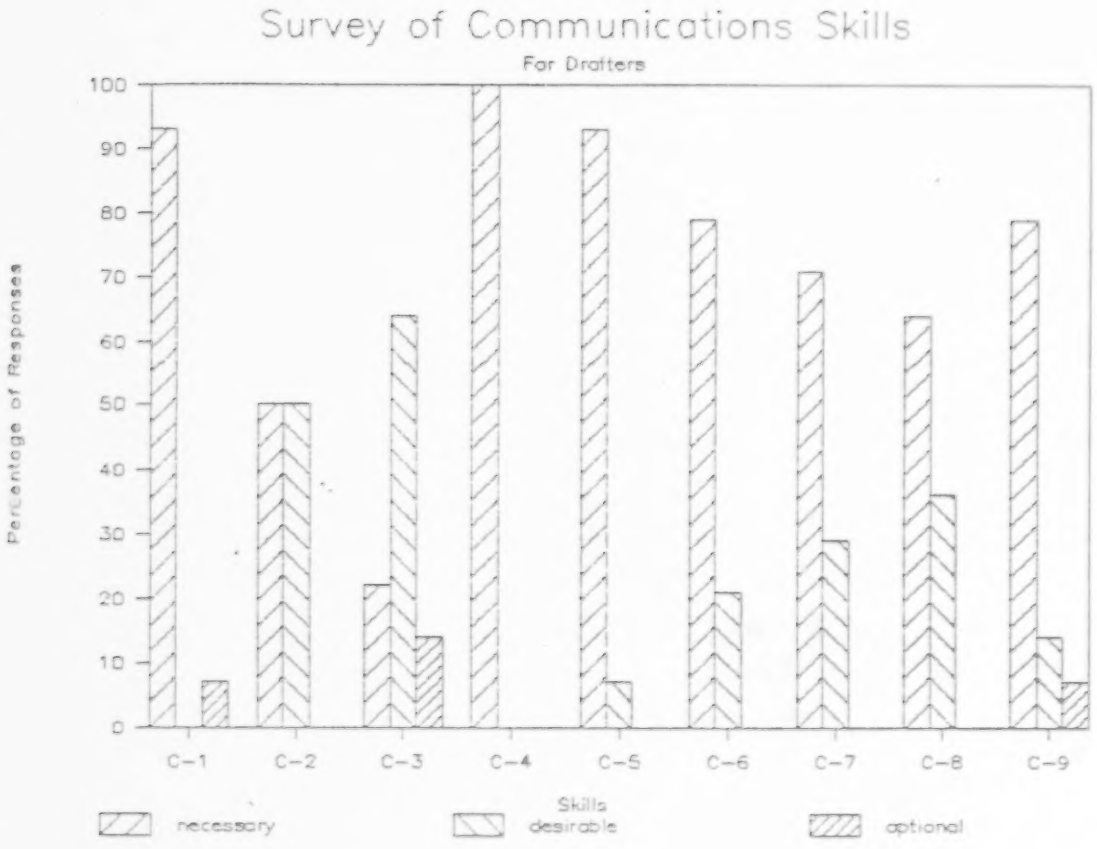
DRAFTERS

MATHEMATICS COMPETENCIES	PERCENTAGE OF RESPONSES		
	NECESSARY	DESIRABLE	OPTIONAL
Add, subtract, mulitply and divide whole numbers, decimals, fractions	14/100%	0/0 %	0/0 %
Round off numbers	14/100%	0/0 %	0/0 %
Raise number to a power (cube, square)	9/64 %	4/29 %	1/07 %
Convert from decimals to fractions vice versa	12/86 %	2/14 %	0/0 %
Determine percentage, percent (rate) base	11/79 %	3/21 %	0/0 %
Compute average, mean, mode	8/57 %	5/36 %	1/07 %
Compute simple interest	1/07 %	4/29 %	9/64 %
Determine discount, commission	1/07 %	1/07 %	12/86 %
Determine cost, profit, overhead	0 %	4/29 %	10/71 %
Figure payroll and taxes	1/07 %	3/21 %	10/71 %
Solve problems involving ratio and proportions	7/50 %	5/36 %	2/14 %
Use graphs, charts, scales, and tables	8/57 %	5/36 %	1/07 %
Add, subtract, multiply and divide units of measure	13/93%	1/07 %	0/0 %
Convert measures (English units to S.I. Metric units, vice versa	11/79%	3/21 %	0/0 %
Solve problems involving time, weight, distance, quantity, volume and area	7/50 %	5/36 %	2/14 %
Perform operations using signed numbers	7/50 %	4/29 %	3/21 %
Read guages, dials, and meters	7/50 %	5/36 %	2/14 %
Compute tolerance	9/71 %	2/14 %	2/14 %
Use measuring instruments such as ruler, protractor, compass, micrometer, caliper	11/79%	3/21%	0/0%
Use formulas to solve problems	8/57%	6/43 %	0/0%
Express a problem in terms of mathematical equation	5/36 %	7/50 %	2/14 %
Solve equations	6/43%	6/43 %	2/14 %
Apply order of operations	5/36%	5/36 %	4/28 %
Apply laws of exponents	2/14%	7/50 %	5/36 %
Graph equations	3/21%	4/29 %	7/50 %
Solve for multi unknowns	1/09%	6/43 %	7/50 %
Identify geometric shapes and lines	10/71%	4/29 %	0/0 %
Solve problems involving geometric shapes, angles, lines and points	10/71%	4/29 %	0/0 %
Solve problems that involve distance	5/36%	4/29 %	5/36 %
Determine functions of angles	8/57%	4/29 %	2/14 %

DRAFTERS

PERCENTAGE OF RESPONSES

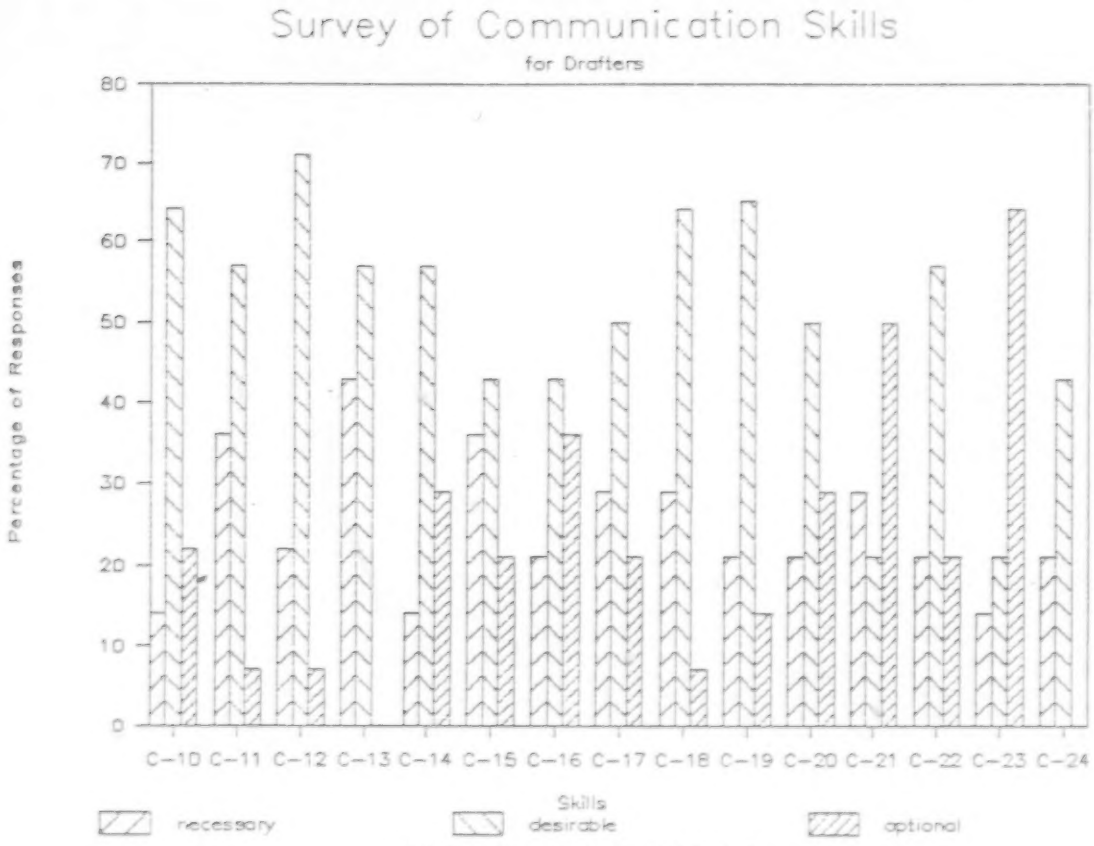
MATHEMATICS COMPETENCIES	NECESSARY	DESIRABLE	OPTIONAL
Use trigometric tables	6/43 %	4/28%	4/28%
Solve right triangle problems using sine, cosine, tangent and pythagorean theorem	8/57%	3/21%	3/21%
Solve problems involving oblique angles	7/50%	3/21%	4/29 %
Apply radian measure to angles	6/43%	6/43%	2/14 %
Solve trigometric equations	7/50%	4/29%	3/21 %
Graph and chart trigometric results	3/21%	6/43%	5/36 %
Use scientific calculator	7/50%	6/43%	1/07 %
Use computer for computations	3/21%	9/64%	2/14 %
Apply elementary statistics	2/14%	6/43%	6/43 %
Perform statistical analysis	1/07%	4/29%	9/64 %



COMMUNICATION SKILLS

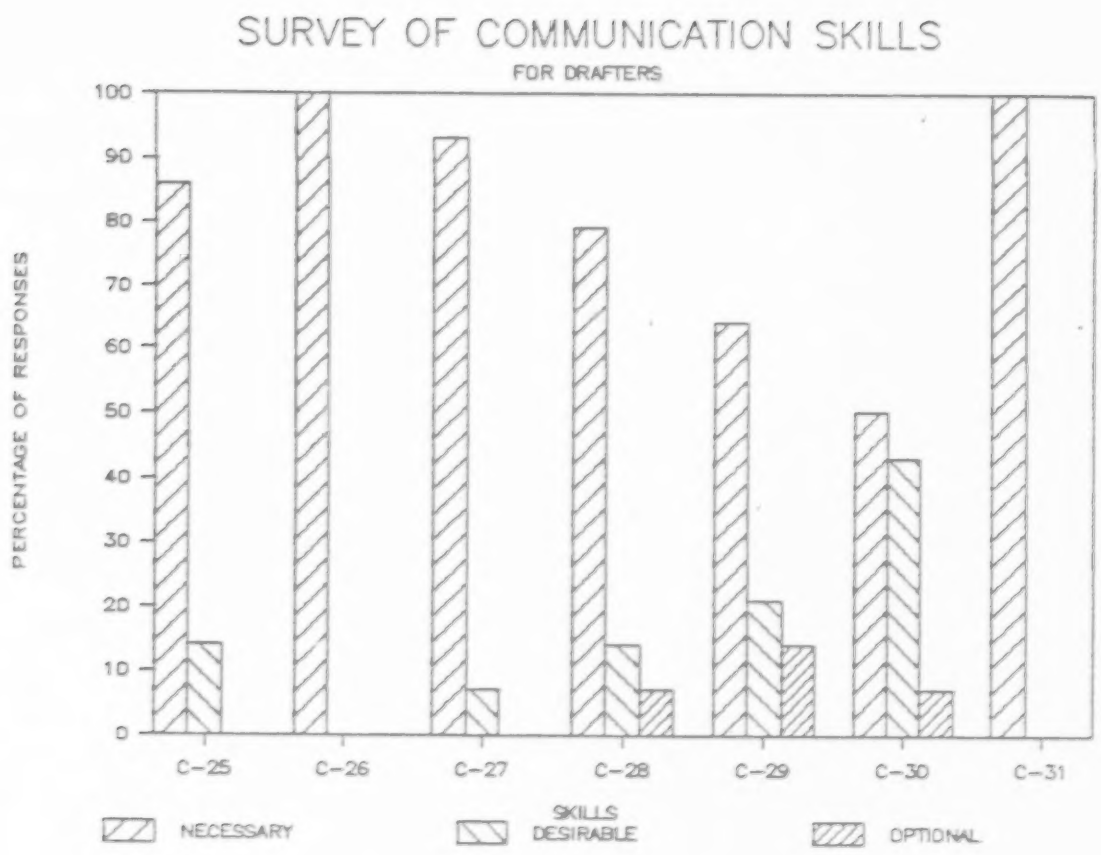
Listening Skills and Oral Communications

C-1 Follow directions
C-2 Take notes
C-3 Summarize information
C-4 Interpret and apply oral communications
C-5 Use standard English
C-6 Speak clearly and precisely
C-7 Use appropriate language
C-8 Describe a product or service
C-9 Explain a process



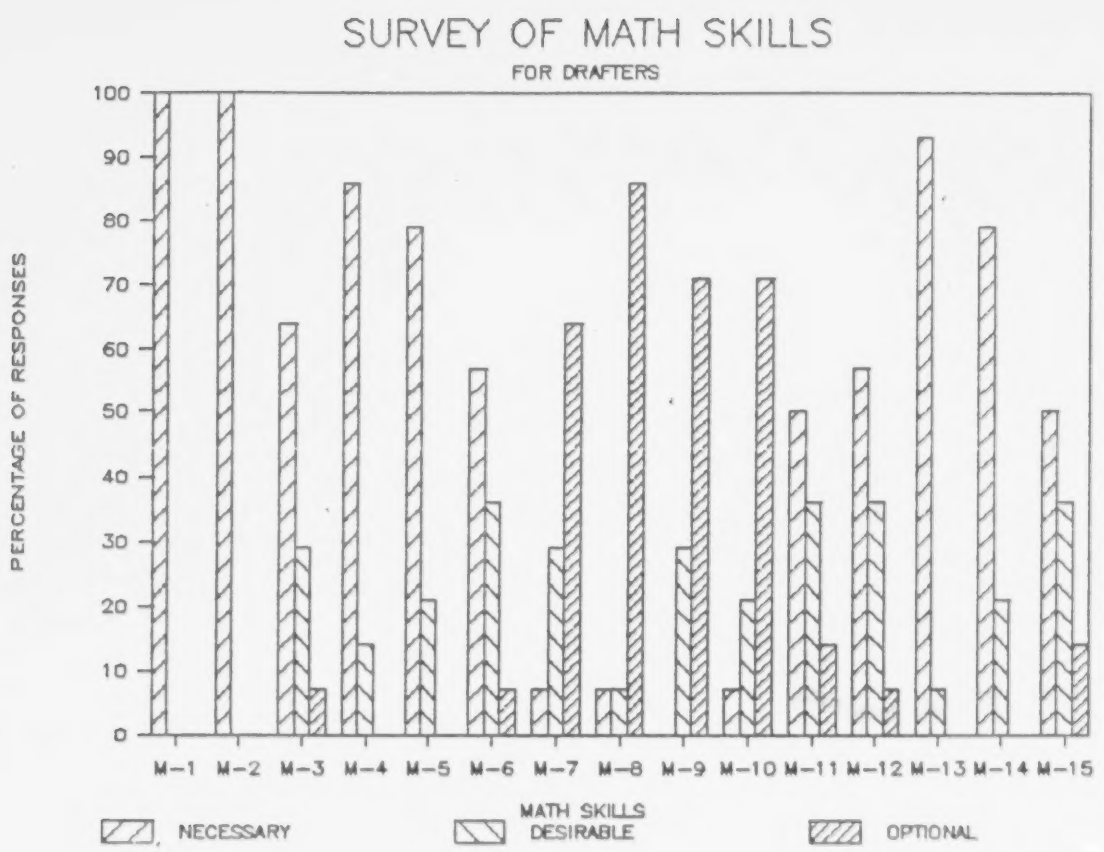
Written Communications

C-10 Punctuate and capitalize correctly
C-11 Spell correctly
C-12 Apply rules of grammar in written communications
C-13 Write clear sentences
C-14 Compose paragraphs, memos, letters
C-15 Complete applications and business forms
C-16 Write a resume
C-17 Write a set of instructions
C-18 Write a description of a product or mechanism
C-19 Write an explanation of a process
C-20 Write a technical definition
C-21 Write an analysis of a problem
C-22 Write simple proposals and reports
C-23 Use acceptable formats for technical writing projects
C-24 Edit for clarity and correctness



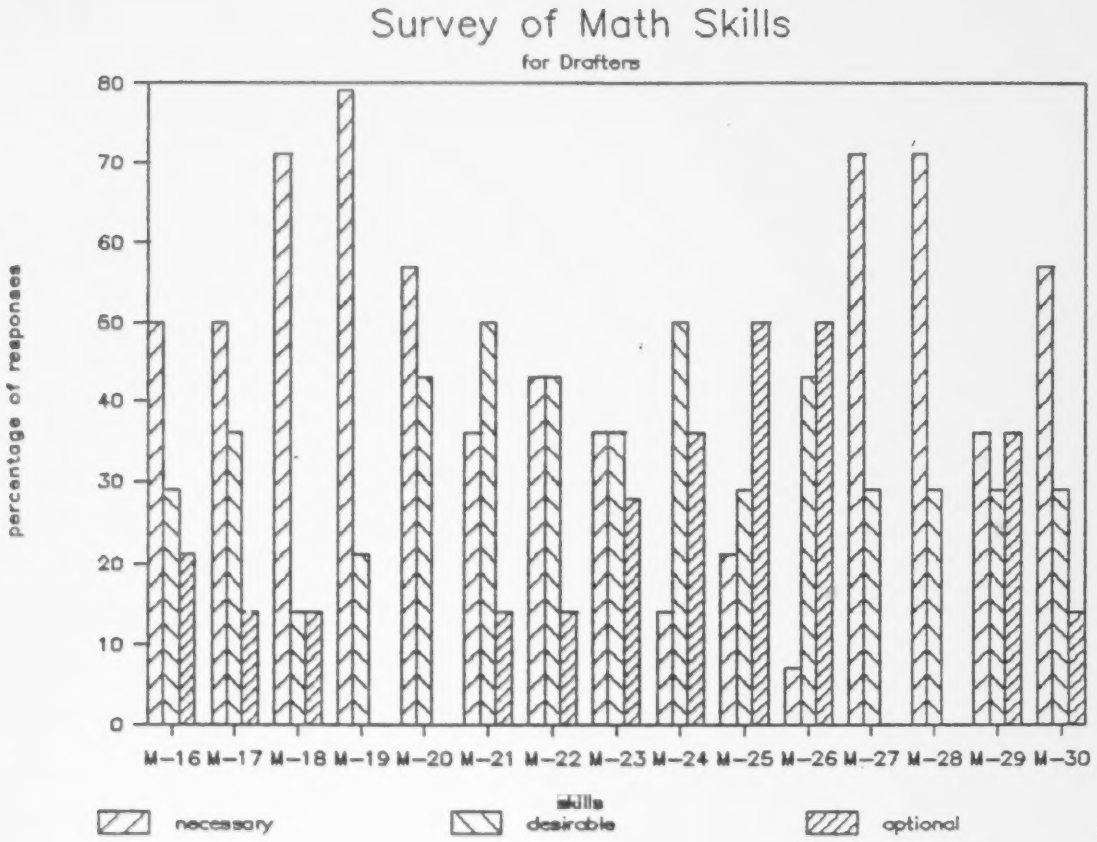
Reading Skills

C-25 Read and interpret manuals
C-26 Read and interpret text materials
C-27 Comprehend vocabulary related to trade
C-28 Read and interpret charts, tables, and graphs
C-29 Read and interpret technical reports
C-30 Read and interpret product information
C-31 Read blueprints



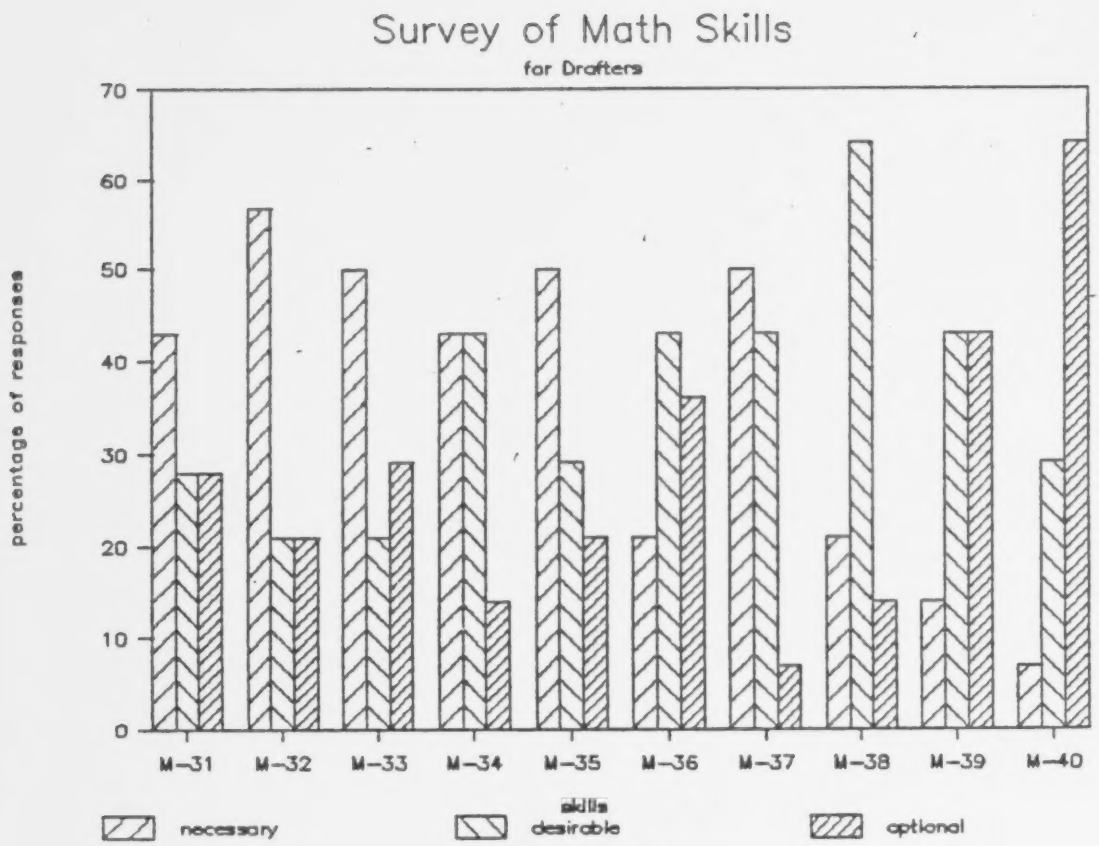
MATHEMATICS
Competencies

M-1 Add, subtract, multiply and divide whole numbers, decimals, and fractions
M-2 Round off numbers
M-3 Raise number to a power (cube, square)
M-4 Convert from decimals to fractions, vice versa
M-5 Determine percentage, percent (rate) base
M-6 Compute average, mean, mode
M-7 Compute simple interest
M-8 Determine discount, commission
M-9 Determine cost, profit, overhead
M-10 Figure payroll and taxes
M-11 Solve problems involving ratio and proportions
M-12 Use graphs, charts, scales and tables
M-13 Add, subtract, multiply and divide units of measure
M-14 Convert measures (English units to S.I. metric units, and vice versa)
M-15 Solve problems involving time, weight, distance, quantity, volume and area



MATHEMATICS
Competencies

M-16 Perform operations using signed numbers
M-17 Read gauges, dials, and meters
M-18 Compute tolerance
M-19 Use measuring instruments such as ruler, protractor, compass, micrometer, caliper
M-20 Use formulas to solve problems
M-21 Express a problem in terms of mathematical equation
M-22 Solve equations
M-23 Apply order of operations
M-24 Apply laws of exponents
M-25 Graph equations
M-26 Solve for multi-unknowns
M-27 Identify geometric shapes and lines
M-28 Solve problems involving geometric shapes, angles, lines, and points
M-29 Solve problems that involve distance
M-30 Determine functions of angles



MATHEMATICS
Competencies

M-31 Use trigonometric tables
M-32 Solve right triangle problems using sine, cosine, tangent and Pythagorean theorem
M-33 Solve problems involving oblique angles
M-34 Apply radian measure to angles
M-35 Solve trigonometric results
M-36 Graph and chart trigonometric results
M-37 Use scientific calculator
M-38 Use computer for computations
M-39 Apply elementary statistics
M-40 Perform statistical analysis

ANALYSIS OF SURVEY CHECKLIST DATA
FOR COSMETOLOGISTS
(10 Respondents)

Three of the four listening skills on the survey were rated necessary by 56 to 100 percent of the respondents. Summarizing information was rated necessary by 40 percent and desirable by 40 percent. All of the oral communication skills were rated necessary by 75 to 100 percent of the respondents. The ability to describe a product or service was rated necessary by 100 percent. Nine of the written communication skills were rated necessary by 50 percent or more of the respondents. These skills were:

Spell correctly	50%
Apply rules of grammar	56%
Write clear sentences	63%
Complete applications and business forms	50%
Write a resume	50%

Five other skills were rated necessary or desirable by a combined percentage of at least 75 percent. They were:

Complete applications and business forms	N=50%	D=25%
Write a resume	N=50%	D=25%
Write an explanation of a process	N=38%	D=38%
Write a set of instructions	N=38%	D=50%
Write a description of a product or mechanism	N=33%	D=56%

Four reading skills were rated necessary by 50 percent or more of the respondents. They were:

Read and interpret manuals	80%
Read and interpret text materials	76%
Comprehend vocabulary related to trade	67%

Read and interpret product information 76%

One reading skill received a combined "necessary" and "desirable" response above 75 percent.

	N	D
Read and interpret charts, tables, and graphs	44%	44%

MATHEMATICS COMPETENCIES

Six mathematics competencies were rated necessary by 50 percent or more of the respondents. They were:

Add, subtract, multiply and divide whole numbers, decimals, fractions	66%
Determine percentage, percent (rate) base	66%
Determine discount, commission	83%
Determine cost, profit, overhead	67%
Figure payroll and taxes	63%
Add, subtract, multiply and divide units of measure	72%

The majority of the other mathematics competencies on the survey were rated optional by 50 to 83 percent of the respondents. Some respondents only rated mathematics competencies in the necessary category and gave no desirable or optional ratings. This lowered the total number of responses for each skill. Skills rated necessary or desirable by a combined rating of 50 percent or more may be significant for cosmetologists. Those skills were:

	N	D
Round off numbers	17%	33%
Convert from decimals to fractions, vice versa	17%	33%
Use graphs, charts, scales and tables	33%	17%
Convert measures (English units to S. I. metric)	40%	10%
Read gauges, charts, and meters	17%	33%

Use formulas to solve problems	N=33%	D=17%
Perform operations using signed numbers	N=40%	D=10%

SUMMARY

Percentage of response tables and graphs of survey responses for cosmetologists follow. The data indicates:

1. Listening and oral communication skills are the most highly rated communication skills.
2. Basic writing skills are necessary.
3. The ability to read and interpret job related materials is necessary.
4. Basic computational and measurement skills as well as basic business math skills are necessary.

COMMUNICATION SKILLS COMPETENCIES	PERCENTAGE OF RESPONSES		
	NECESSARY	DESIRABLE	OPTIONAL
LISTENING SKILLS			
Follow directions	10/100%	0/0%	0/0%
Take notes	8/80%	1/10%	1/10%
Summarize information	4/40%	4/40%	2/20%
Interpret and apply oral communications (9 responses)	5/56%	1/11%	3/33%
ORAL COMMUNICATIONS			
Use standard English (9 responses)	8/89%	0/0%	1/11%
Speak clearly and precisely	9/90%	1/10%	0/0%
Use appropriate language (8 responses)	6/75%	2/25%	0/0%
Describe a product or service (8 responses)	8/100%	0/0%	0/0%
Explain a process (7 responses)	7/88%	0/0%	0/0%
WRITTEN COMMUNICATIONS			
Punctuate and capitalize correctly (9 responses)	5/56%	1/11%	3/33%
Spell correctly (9 responses)	5/56%	2/22%	2/22%
Apply rules of grammar in written communications (9 responses)	5/56%	1/11%	3/33%
Write clear sentences (8 responses)	5/63%	1/13%	2/25%
Compose paragraphs, memos, letters (9 responses)	2/22%	3/33%	4/45%
Complete applications and business forms (8 responses)	4/50%	2/25%	2/25%
Write a resume (8 responses)	4/50%	2/25%	2/25%
Write a set of instructions (8 responses)	3/38%	4/50%	1/12%
Write a description of a product or mechanism (9 responses)	3/33%	5/56%	1/11%
Write an explanation of a process (8 responses)	3/38%	3/38%	2/26%
Write a technical definition (7 responses)	1/14%	4/57%	2/29%
Write an analysis of a problem (7 responses)	1/14%	4/57%	2/29%
Write simple proposals and reports (9 responses)	1/11%	5/56%	3/33%

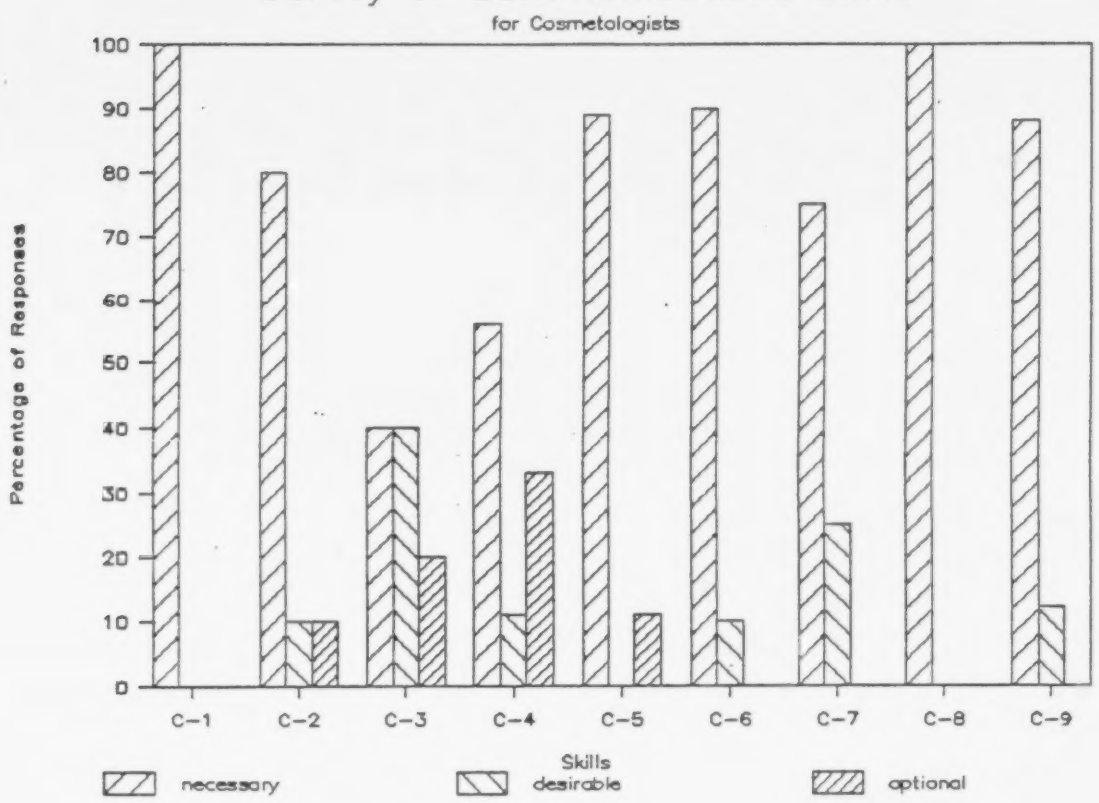
COSMETOLOGISTS

COMMUNICATION SKILLS COMPETENCIES	PERCENTAGE OF RESPONSES NECESSARY	DESIRABLE	OPTIONAL
Use acceptable formats for technical writing projects (8 responses)	1/12 %	5/63%	2/25%
Edit for clarity and correctness (8 responses)	1/12 %	5/63 %	2/25%
READING SKILLS			
Read and interpret manuals	8/80%	1/10 %	1/10%
Read and interpret text materials (8 responses)	6/76%	1/12 %	1/12%
Comprehend vocabulary related to trade (9 responses)	6/67%	2/22 %	1/11%
Read and interpret charts, tables, and graphs (9 responses)	4/44%	4/44 %	1/12%
Read and interpret technical reports (7 reports)	1/14%	4/57 %	2/29%
Read and interpret product information (8 responses)	6/76%	1/12 %	1/12%
Read blueprints (7 responses)	1/14%	2/29 %	4/57%

MATHEMATICS COMPETENCIES	COSMETOLOGISTS PERCENTAGE OF RESPONSES		
	NECESSARY	DESIRABLE	OPTIONAL
Add, subtract, mulitply and divide whole numbers, decimals, fractions (6 responses)	4/66%	1/17 %	1/17%
Round off numbers (6 responses)	1/17%	2/33 %	3/50%
Raise number to a power (cube, square) (9 responses)	4/44%	1/12 %	4/44%
Convert from decimals to fractions vice versa (6 responses)	1/17%	2/33 %	3/50%
Determine percentage, percent (rate) base (6 responses)	4/66%	1/17 %	1/17%
Compute average, mean, mode (6 responses)	1/17%	1/17 %	4/66%
Compute simple interest (6 responses)	1/17%	1/17 %	4/66%
Determine discount, commission (6 responses)	5/83%	1/17 %	0/0 %
Determine cost, profit, overhead (6 responses)	4/67%	0/0 %	2/33%
Figure payroll and taxes (8 responses)	5/63%	0/0 %	3/37%
Solve problems involving ratio and proportions (6 responses)	1/17%	1/17%	4/66%
Use graphs, charts, scales, and tables (6 responses)	2/33%	1/17%	3/50%
Add, subtract, multiply and divide units of measure (7 responses)	5/72%	1/14%	1/14%
Convert measures (English units to S.I. Metric units, vice versa (5 responses)	2/40%	1/20%	2/40%
Solve problems involving time, weight, distance, quantity, volume and area (6 responses)	1/17%	1/17%	4/66%
Perform operations using signed numbers	4/40%	1/10%	5/50%
Read guages, dials, and meters (6 responses)	1/17%	2/33%	3/50%
Compute tolerance (6 responses)	0/0%	1/17%	5/83%
Use measuring instruments such as ruler, protractor, compass, micrometer, caliper (6 responses)	0/0%	1/17%	5/83%
Use formulas to solve problems (6 responses)	2/33%	1/17%	3/50%
Express a problem in terms of mathematical equation (6 responses)	0/0%	1/17%	5/83%
Solve equations (6 responses)	0/0%	1/17%	5/83%
Apply order of operations (6 responses)	0/0%	1/17%	5/83%
Apply laws of exponents (6 responses)	0/0%	1/17%	5/83%
Graph equations (6 responses)	0/0%	1/17%	5/83%
Solve for multi unknowns (6 responses)	0/0%	1/17%	5/83%
Identify geometric shapes and lines (6 responses)	1/17%	1/17%	4/66%
Solve problems involving geometric shapes, angles, lines and points (5 responses)	0/0%	1/20%	4/80%
Solve problems that involve distance (6 responses)	0/0%	1/17%	5/83%
Determine functions of angles (5 responses)	0/0%	1/20%	4/80%

COSMETOLOGISTS
PERCENTAGE OF RESPONSES

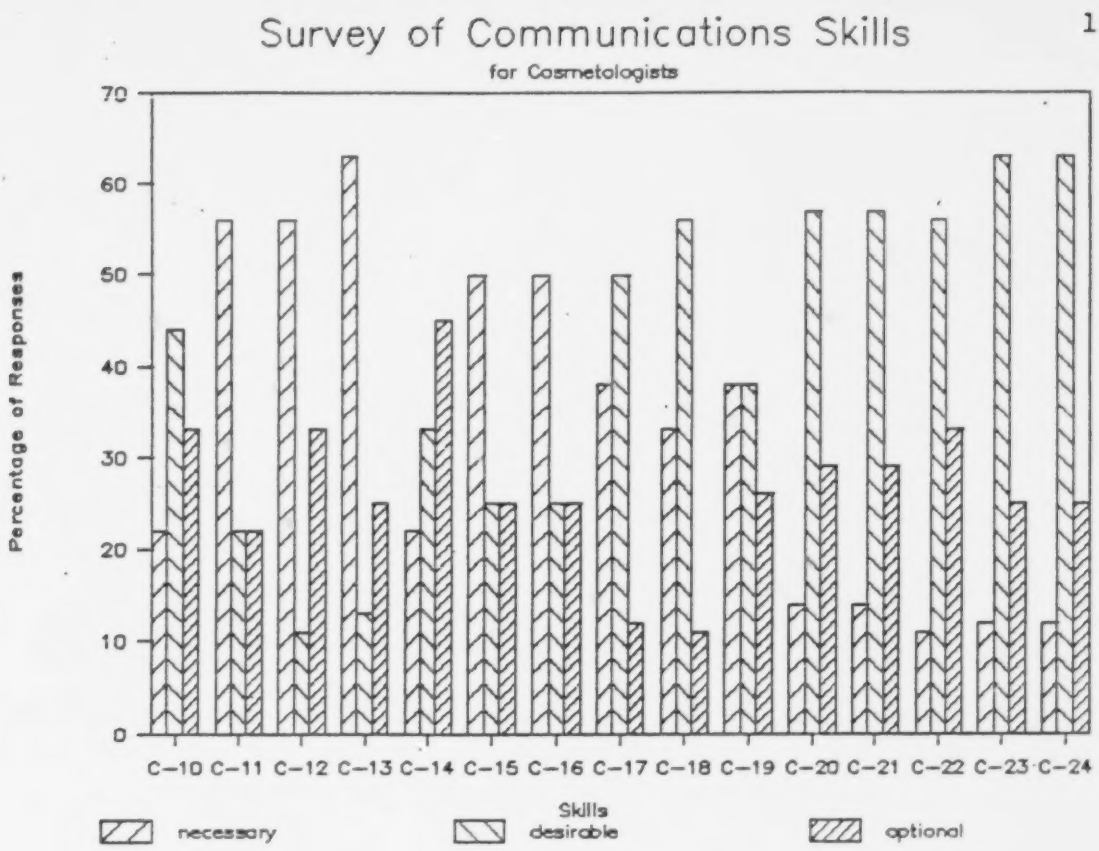
MATHEMATICS COMPETENCIES	NECESSARY	DESIRABLE	OPTIONAL
Use trigometric tables (6 responses)	0/0%	1/17 %	5/83 %
Solve right triangle problems using sine, cosine, tangent and pythagorean theorem (6 responses)	0/0%	1/17 %	5/83 %
Solve problems involving oblique angles (6 responses)	0/0%	1/17 %	5/83 %
Apply radian measure to angles (6 responses)	0/0%	1/17 %	5/83 %
Solve trigometric equations (6 responses)	0/0%	1/17 %	5/83 %
Graph and chart trigometric results (6 responses)	0/0%	1/17 %	5/83 %
Use scientific calculator (4 responses)	0/0%	1/25 %	3/75 %
Use computer for computations (3 responses)	0/0%	1/33 %	2/67 %
Apply elementary statistics (4 responses)	0/0%	1/25 %	3/75 %
Perform statistical analysis (5 responses)	0/0%	1/20 %	4/80 %



COMMUNICATION SKILLS

Listening Skills and Oral Communications

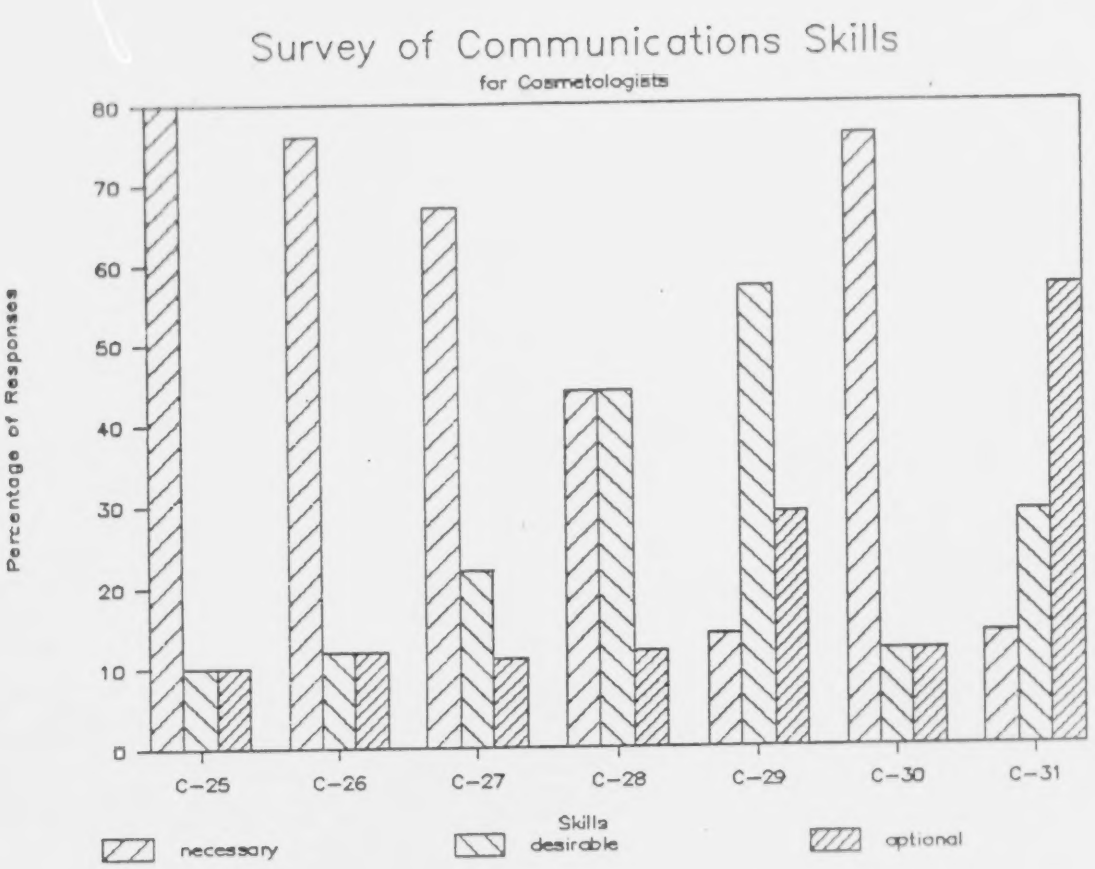
C-1 Follow directions
C-2 Take notes
C-3 Summarize information
C-4 Interpret and apply oral communications
C-5 Use standard English
C-6 Speak clearly and precisely
C-7 Use appropriate language
C-8 Describe a product or service
C-9 Explain a process



COMMUNICATION SKILLS

Written Communications

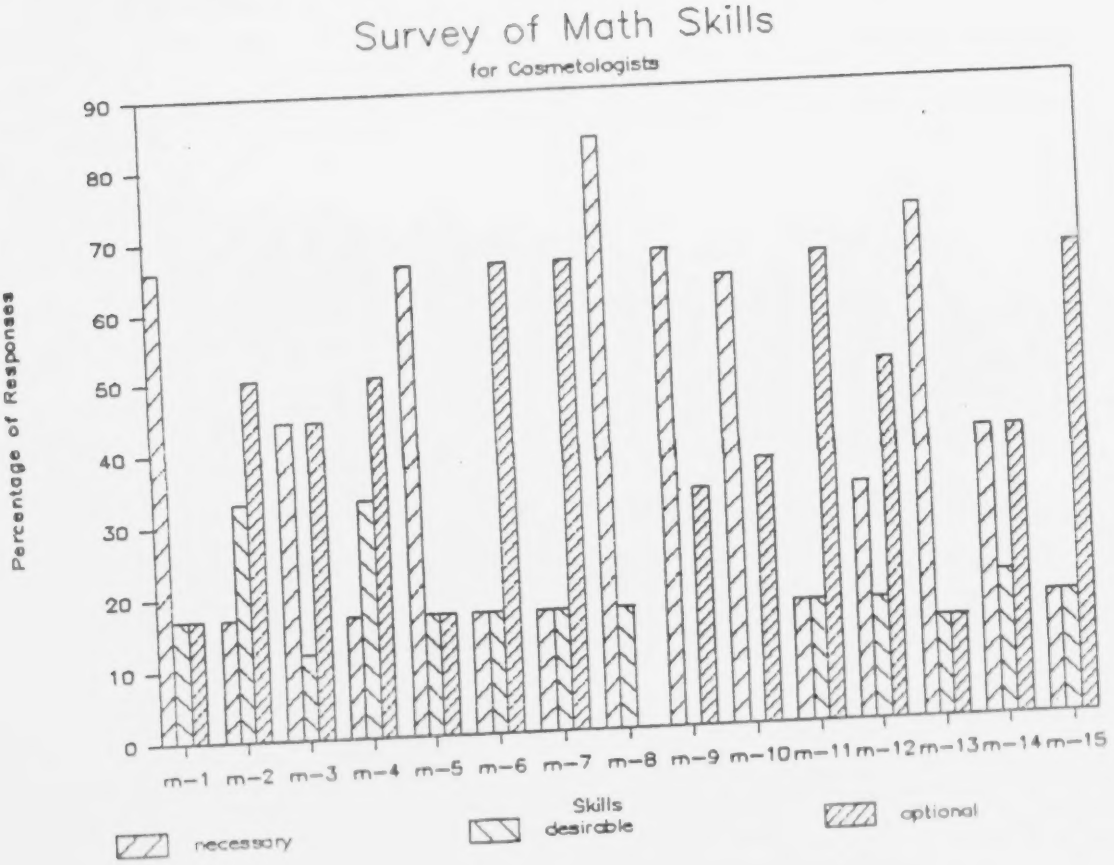
C-10 Punctuate and capitalize correctly
C-11 Spell correctly
C-12 Apply rules of grammar in written communications
C-13 Write clear sentences
C-14 Compose paragraphs, memos, letters
C-15 Complete applications and business forms
C-16 Write a resume
C-17 Write a set of instructions
C-18 Write a description of a product or mechanism
C-19 Write an explanation of a process
C-20 Write a technical definition
C-21 Write an analysis of a problem
C-22 Write simple proposals and reports
C-23 Use acceptable formats for technical writing projects
C-24 Edit for clarity and correctness



COMMUNICATION SKILLS

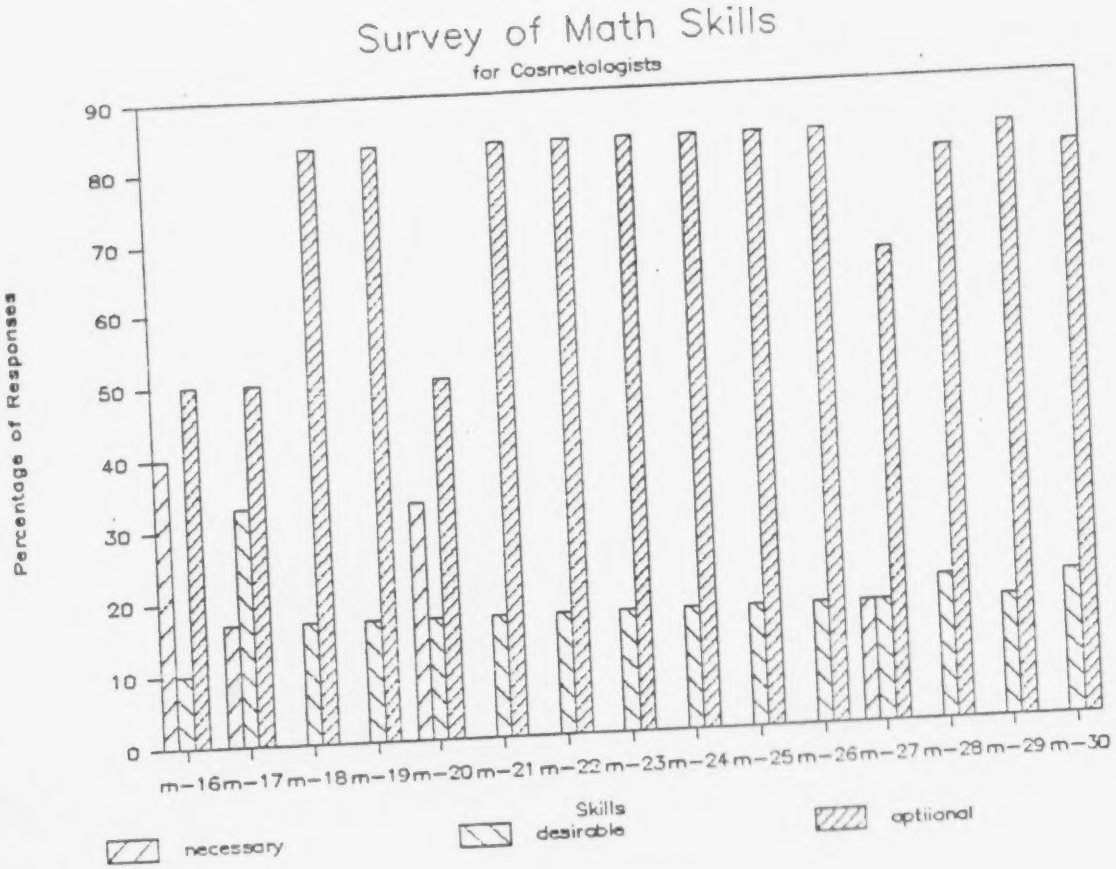
Reading Skills

C-25 Read and interpret manuals
C-26 Read and interpret text materials
C-27 Comprehend vocabulary related to trade
C-28 Read and interpret charts, tables, and graphs
C-29 Read and interpret technical reports
C-30 Read and interpret product information
C-31 Read blueprints



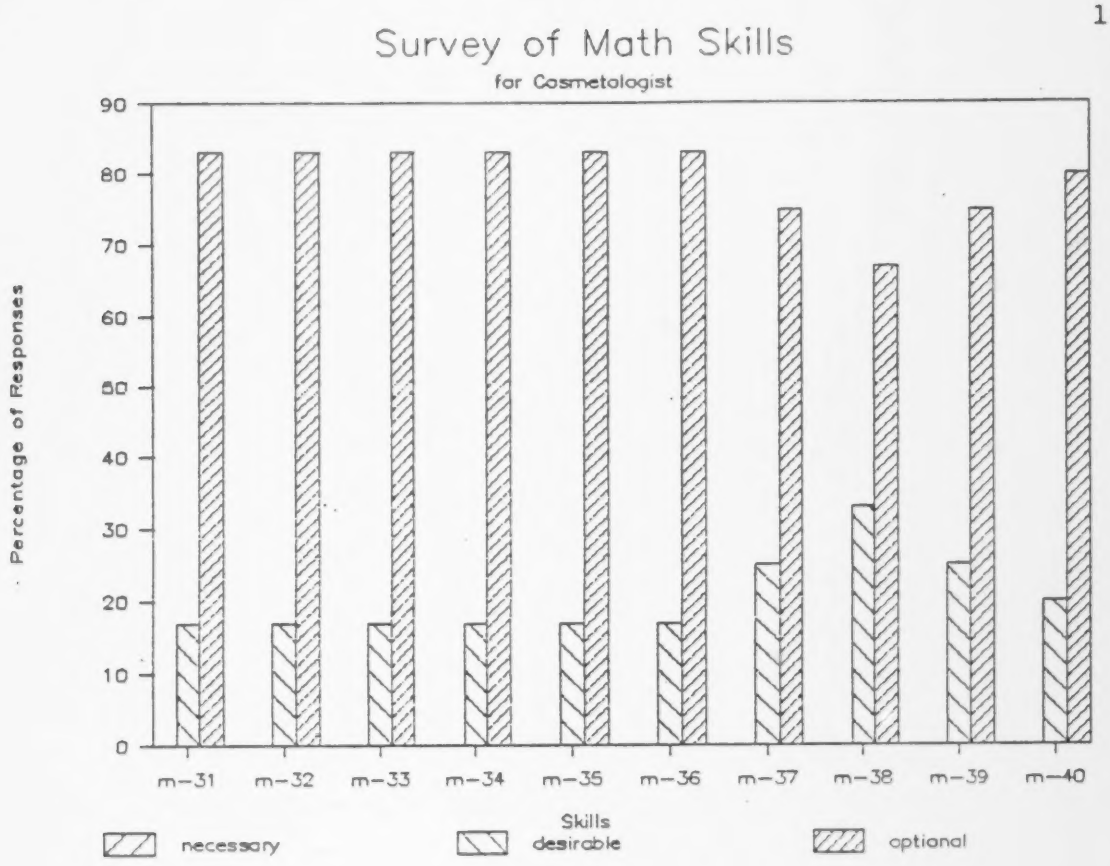
MATHEMATICS
Competencies

M-1	Add, subtract, multiply and divide whole numbers, decimals, and fractions
M-2	Round off numbers
M-3	Raise number to a power (cube, square)
M-4	Convert from decimals to fractions, vice versa
M-5	Determine percentage, percent (rate) base
M-6	Compute average, mean, mode
M-7	Compute simple interest
M-8	Determine discount, commission
M-9	Determine cost, profit, overhead
M-10	Figure payroll and taxes
M-11	Solve problems involving ratio and proportions
M-12	Use graphs, charts, scales and tables
M-13	Add, subtract, multiply and divide units of measure
M-14	Convert measures (English units to S.I. metric units, and vice versa)
M-15	Solve problems involving time, weight, distance, quantity, volume and area



MATHEMATICS
Competencies

M-16 Perform operations using signed numbers
M-17 Read gauges, dials, and meters
M-18 Compute tolerance
M-19 Use measuring instruments such as ruler, protractor, compass, micrometer, caliper
M-20 Use formulas to solve problems
M-21 Express a problem in terms of mathematical equation
M-22 Solve equations
M-23 Apply order of operations
M-24 Apply laws of exponents
M-25 Graph equations
M-26 Solve for multi-unknowns
M-27 Identify geometric shapes and lines
M-28 Solve problems involving geometric shapes, angles, lines, and points
M-29 Solve problems that involve distance
M-30 Determine functions of angles



MATHEMATICS
Competencies

M-31 Use trigonometric tables
M-32 Solve right triangle problems using sine, cosine, tangent and Pythagorean theorem
M-33 Solve problems involving oblique angles
M-34 Apply radian measure to angles
M-35 Solve trigonometric results
M-36 Graph and chart trigonometric results
M-37 Use scientific calculator
M-38 Use computer for computations
M-39 Apply elementary statistics
M-40 Perform statistical analysis

COMMON RELATED SKILLS

Common related skills are those skills identified by survey respondents representing all five occupations as necessary or highly desirable. Necessary skills are those skills rated necessary by 50 percent or more of the respondents for each occupation. Skills rated necessary or desirable by a combined response of 75 percent are considered highly desirable. A combined "necessary and desirable" response of 50 percent or more for cosmetologists is included in the identification of common related skills because the number of survey respondents is smaller than for the other occupations.

COMMUNICATION SKILLS

All of the listening and oral communication skills listed on the survey are necessary or highly desirable. The ability to follow oral directions and the ability to interpret and apply oral information are the most important listening skills. The ability to describe a product or service, the ability to explain a process and use standard English are the most important oral communication skills.

There was no clear pattern of responses to written communication skills. The ability to write an explanation of a process and the ability to write a description of a product or mechanism are the most important skills for all five occupations. The ability to write an analysis of a problem is necessary for mechanics, electricians, and air conditioning/refrigeration technicians. The ability to

write simple proposals and reports is highly desirable for drafters, electricians, and air conditioning/ refrigeration technicians. Punctuation, spelling, and grammar are necessary for cosmetologists and highly desirable for the skilled trades.

Writing skills identified as necessary or highly desirable by respondents for three of the five occupations are suggested as core skills for all five. Two skills which were not identified as necessary on-the-job were: (a) compose paragraphs, memos, letters, and (b) write a resume. Composing paragraphs and letters and writing a resume are skills needed to find a job.

All reading skills on the survey were rated necessary for all five occupations with the exception of two skills which are not needed by cosmetologists. These skills are reading and interpreting technical reports and reading blueprints.

A complete list of common related communication skills follows:

Common Related Communication Skills

LISTENING SKILLS

Follow directions
Take notes
Summarize information
Interpret and apply oral communication

ORAL COMMUNICATIONS

Use standard English
Speak clearly and precisely
Use appropriate language
Describe a product or service
Explain a process

WRITTEN COMMUNICATIONS

Punctuate and capitalize correctly
Spell correctly
Apply rules or grammar in written communications
Write clear sentences
Complete applications and business forms
Write a set of instructions
Write a description of a product or mechanism
Write an explanation of a process
Write an analysis of a problem
Write simple proposals and reports
Use acceptable formats for technical writing projects
Edit for clarity and correctness

READING SKILLS

Read and interpret manuals
Read and interpret text materials
Comprehend vocabulary related to trade
Read and interpret charts, tables, and graphs
*Read and interpret technical reports
Read and interpret product information
*Read blue prints

*Not needed by cosmetologists.

MATHEMATICS COMPETENCIES

Mathematics competencies which are needed by all five occupations are basic computational skills, measurement and conversion skills, and problem-solving skills related to ratio and proportions and the use of formulas.

Core Related Mathematics Competencies

Add, subtract, multiply and divide whole numbers, decimals, fractions
Round off numbers
Raise number to a power (cube, square)
Convert from decimals to fractions vice versa
Determine percentage, percent (rate) base
Solve problems involving ratio and proportions
Use graphs, charts, scales, and tables
Add, subtract, multiply, and divide units of measure
Convert measures (English units to S. I. Metric units, vice versa
Solve problems involving time, weight, distance, quantity, volume and area
Read gauges, dials, and meters

*Compute tolerance
Use measuring instruments such as a ruler, protractor, compass, micrometer, caliper
Use formulas to solve problems

*Not needed by cosmetologists

SPECIALIZED COMMUNICATION SKILLS

Most communication skills surveyed are generic and have application across all of the occupational areas. The levels of application vary as well as the complexity. Training manuals, service and operation manuals, as well as textbooks have a variety of reading levels. Oral communication skills range from communicating with customers about services to communicating with supervisors and engineers about highly technical procedures. Writing skills may range from an advertisement for a hair show to an automotive repair work order or a bid proposal for an industrial cooling system.

No attempt is made to identify specialized listening skills. Oral communication skills, written communication skills and reading skills which vary in their application to the five occupations are listed.

Specialized Communication Skills

The following skills have specialized application for the five vocational areas.

Describe a product or service (orally)
Explain a process (orally)
Write a description of a product or mechanism
Write an explanation of a process
Write an analysis of a problem
Write simple proposals and reports
Read and interpret manuals
Comprehend vocabulary related to trade
Read and interpret charts, tables, and graphs
Read and interpret technical reports
Read and interpret product information
Read blueprints

SPECIALIZED MATH COMPETENCIES

Certain math skills vary in their application to different occupations. For example, reading gauges, dials and meters is a generic skill used in many occupations but it is also specialized. Types of measuring instruments, charts, graphs, and scales vary also. Where there is a significant difference in the application of such skills they are listed as specialized skills. The following skills have been identified as specialized skills for the occupations addressed in the study.

Specialized Math Skills for Mechanics

- Solve problems involving time, weight, distance, quantity, volume and area
- Use graphs, charts, scales, and tables
- Perform operations using signed numbers
- Read gauges, dials, and meters
- Use measuring instruments such as rulers, protractor, compass, micrometer and caliper
- Use formulas to solve problems
- Compute tolerance
- Solve equations
- Identify geometric shapes, angles, lines and points

- Solve problems involving geometric angles, lines and points
- Determine functions of angles

Specialized Math Skills for Electricians

- Compute average, mean, mode
- Use graphs, charts, scales and tables
- Solve problems involving time, weight, distance, quantity, volume and area
- Perform operations using signed numbers
- Read gauges, dials and meters
- Compute tolerance
- Use measuring instruments such as ruler, protractor, compass, micrometer and caliper
- Use formulas to solve problems
- Express a problem in terms of a mathematic equation
- Solve equations
- Apply laws of exponents
- Identify geometric shapes, angles, lines and points
- Solve problems that involve distance
- Determine functions of angles
- Use scientific calculator

Specialized Math Skills for Air Conditioning/ Refrigeration Technicians

- Compute average, mean and mode
- Determine discount and commission
- Use graphs, charts, scales and tables
- Solve problems involving time, weight, distance, quantity, volume and area
- Perform operations using signed numbers
- Read gauges, dials, and meters
- Compute tolerance
- Use formulas to solve problems
- Express a problem in terms of a mathematic equation
- Solve equations
- Apply laws of exponents
- Identify geometric shapes and lines
- Determine functions of angles

Specialized Math Skills for Drafters

- Compute average, mean and mode
- Use graphs, charts, scales and tables
- Solve problems involving time, weight, distance, quantity, volume and area
- Perform operations using signed numbers
- Read gauges, dials and meters
- Compute tolerance
- Use measuring instruments such as ruler, protractor, compass, micrometer, caliper

- Use formulas to solve problems
- Express a problem in terms of a mathematical equation
- Solve equations
- Identify geometric shapes and lines
- Solve problems involving geometric shapes, angles, lines and points
- Solve right triangle problems using sine, cosine, tangent and Pythagorean theorem
- Solve problems involving oblique angles
- Apply radian measure to angles
- Solve trigonometric equations
- Use scientific calculator
- Use computer for computations

Specialized Math Skills for Cosmetologists

Business math skills are skills needed by cosmetologists in addition to basic computational and measurement skills.

- Determine discounts and commission
- Determine cost, profit and overhead
- Figure payroll and taxes

One general skill which has a special application for cosmetology is:

- Add, subtract, multiply and divide units of measure

RECOMMENDATIONS FOR CURRICULUM IMPROVEMENT

The following recommendations for curriculum improvement are based on the review of research, the review of related instruction across the State, the survey of businesses and industry, and discussions with faculty and administrators.

1. Continue to refine the remediation program. Recognizing that remediation programs across the State are also in the developmental stage, Calhoun's program has the potential to serve as a model. The following suggestions are offered as ways to strengthen the effectiveness of the program.

   a. Work with College testing personnel to clearly identify ASSET scores and other criteria for placement in the remediation program so that all technical division students are not required to participate in diagnostic testing. Until ASSET scores are validated the scores used for placement in the Junior College remedial reading class and remedial math classes might be used.

   b. Add a reading component to the program with a focus on content reading skills and occupational reading skills.

   c. Identify exit levels that students must reach based on minimum skills needed to be successful with the content of required related and vocational courses. Math remediation should focus on basic arithmetic skills.

Language remediation should include fundamental usage, grammar and spelling.

d. Provide more flexibility in scheduling remediation based on the amount of remediation needed by individual students. Remediation should begin in the first quarter of matriculation but may not be needed a full quarter. Students in need of extensive remediation may need to complete such remediation before enrollment in selected technical courses.

e. Increase the use of computer assisted instruction and non-print media.

2. The focus of Communications 101 should be the development of applied communication skills needed in the workplace. There should be a balanced treatment of listening, speaking, reading, and writing skills. Communications 101 has tried to meet the needs of two types of students; those entering the work-force following completion of diploma requirements and those needing preparation for the English requirements in degree programs. This dual focus should be eliminated. The incorporation of modules from the Applied Communication Program developed by the Agency for Instructional Technology as well as additional curriculum materials which focus on work related communication skills is recommended.

3. A second communications course which focuses on developing work-related vocabulary, reading and writing skills should be offered as a diploma requirement in the more technical fields. This course should be equivalent to English 090 in the Junior College Division. This course would replace Communications 108 which is currently required only for the diploma in Electricity.

4. A cooperative assessment of Technical and Junior College Division math courses offerings should be initiated to increase course options for students and decrease duplication of courses by both divisions. It should be determined whether some courses in the technical division are equivalent to courses in the Junior College division. For example, MAH 110, Basic Mathematics, and MTH 090, Basic Mathematics, may be equivalent. MAH 120, Introductory Algebra, may be equivalent to MTH 091, Developmental Algebra I. Both divisions also offer a technical mathematics sequence covering similar skills and concepts.

5. The sequence of related mathematics courses should be revised and appropriate ASSET placement scores and prerequisites established. In programs where the mathematics requirements begin above basic mathematics, students should be required to take the prerequisites or have the required

placement score. Currently the prerequisites for MAH 130-Geometry and Trigonometry vary for the two programs which require the course. Technical Math I, which begins with intermediate algebra, has no prerequisite.

6. Since algebra, geometry, and trigonometry are needed in Design Drafting, Electricity Technology, Electronics Technology and Machine Shop, math course offerings for these programs should be combined where possible. Equivalent college level math courses should be identified so that students have the option of completing math requirements for the degree concurently with diploma requirements. This may necessitate a revision of interdivisional degree requirements for some programs.

7. The importance of related instruction to a student's success in the Technical Division and in the workplace must be recognized and supported by the faculty. The faculty should insure that students complete the required related courses and that skills learned are reinforced and mastered in each technical program.

APPENDIX: Survey Instrument

Calhoun Community College

RELATED SKILLS IN THE MARKETPLACE

A SURVEY OF BUSINESS AND INDUSTRY

JOHN C. CALHOUN STATE COMMUNITY COLLEGE
TECHNICAL DIVISION

SPRING, 1989

CALHOUN COMMUNITY COLLEGE TECHNICAL DIVISION
OVERVIEW OF CURRICULUM STUDY

The Technical Division of Calhoun College is conducting a study of its related instruction in mathematics and communications for five vocational diploma programs. The programs are: Electrical Technology, Automotive Mechanics Technology, Refrigeration and Air Conditioning, Design Drafting Technology, and Cosmetology. The goal of the study is to provide a framework for program improvement through an assessment of basic skills instructional needs.

The major objective of the study is to determine, through a survey of business and industry, what specialized related skills should be mastered for optimal job performance in each of the five vocational areas. A second objective is the identification and development of a common core of related skills for all of the vocational areas studied.

In addition to information gained from business and industry, current research in related instruction will be reviewed. The information gathered from this study will be used to evaluate course requirements and course content.

TECHNICAL COLLEGE CURRICULUM STUDY
SURVEY OF BUSINESS AND INDUSTRY

PURPOSE - This survey is designed to gather the perceptions of industry and business about skills in communications and mathematics needed by employees. The survey will be used to determine curriculum needs in the Technical Division at Calhoun College. Your candid response will be appreciated. All responses will be confidential.

Section A

Name _____

Job Title _____

Company _____

Address _____

1. What kind of business or industry do you represent?

____Communications
____Construction
____Distribution or Transportation of Goods and Services
____Equipment or Vehicle Servicing
____Engineering Firm
____Manufacturing of Products
____Merchandising or Sales
____Natural Resources
____Personal Services
____Utility Services (Power, Water, Fuel)
____Government
____Other (Please write in)

2. To what extent do you personally participate in the process of selecting and orienting new workers? (Check one that is most applicable)

____Process applications, recruit and screen applicants, and interview applicants
____Approve applicants for employment
____Formally train/orient new employees
____Directly supervise workers performance
____Other

3. What is your current employment? (Check one)

____Under 10 Employees
____10-25 Employees
____50-100 Employees
____250-500 Employees
____500-1000 Employees
____1000-3000 Employees
____Over 3000

4. Which of the following types of personnel does your company employ?

____Electricians
____Mechanics
____Refrigeration/Air Conditioning Technicians
____Drafters
____Cosmetologists

Section B

1. Do you think communication skills should be a part of a vocational program which trains the type of employees you hire?

2. Which of the following types of communication skills are required for optimal job performance?

   Check all that apply

____Listening Skills
____Speaking Skills
____Writing Skills
____Reading Skills

3. In which communication skills areas do you find new or entry level employees lacking sufficient competence?

____Listening
____Speaking
____Writing
____Reading

4. Are employees required to read and interpret technical materials?

5. Are employees expected to know technical vocabulary?

6. Are employees required to complete routine forms describing work completed, requests for material, etc..?

7. Are employees required to write reports?

8. Are spelling and grammar skills important on the job?

9. Are employees required to communicate with clients to explain services?

10. Would training in oral communications be helpful to your employees?

11. Would training in technical writing be useful to your employees?

12. Do you expect employees to have skills in advanced mathematics?

13. Which of the following types of math courses would you recommend for training for your profession?

_____Business Math
_____Algebra
_____Geometry
_____Trigonometry
_____Calculus
_____Computer Mathematics
_____Physics
_____Other

14. Does your company assess the math competence of prospective employees?

15. What major math skill deficiencies do entry level employees have?

Questions 16 - 19 refer to employers of drafters only. All respondents should complete Section C - specific skills, which begins on page 5.

16. What are your drafting specialty areas?

17. How do you classify drafters?

_____Junior Drafters
_____Detailers
_____Designers
_____illustrators
_____Other

18. To what extent do math skills needs vary for the different classifications of drafters?

19. Do you require drafters to use CAD and manual drafting?

SECTION C - Specific Skills

Specific communications and mathematics skills are listed in the matrices which follow. Please review the skills and rate their importance to specified jobs using the codes below:

✓ = Necessary for the specified job

X = Desirable skill that may enhance employment

O = Optional skill that would seldom be needed

COMMUNICATION SKILLS COMPETENCIES	MECHANIC	ELECTRICIAN	A/C REFRIG. TECHNICIAN	DRAFTER	COSMETOLOGIST		
LISTENING SKILLS							
Follow directions							
Take notes							
Summarize information							
Interpret and apply oral communications							
ORAL COMMUNICATIONS							
Use standard English							
Speak clearly and precisely							
Use appropriate language							
Describe a product or service							
Explain a process							
WRITTEN COMMUNICATIONS							
Punctuate and capitalize correctly							
Spell correctly							
Apply rules of grammar in written communications							
Write clear sentences							
Compose paragraphs, memos, letters							
Complete applications and business forms							
Write a resume							
Write a set of instructions							
Write a description of a product or mechanism							
Write an explanation of a process							
Write a technical definition							
Write an analysis of a problem							
Write simple proposals and reports							

COMMUNICATION SKILLS COMPETENCIES	MECHANIC	ELECTRICIAN	A/C REFRIG. TECHNICIAN	DRAFTER	COSMETOLOGIST		
Use acceptable formats for technical writing projects							
Edit for clarity and correctness							
READING SKILLS							
Read and interpret manuals							
Read and interpret text materials							
Comprehend vocabulary related to trade							
Read and interpret charts, tables, and graphs							
Read and interpret technical reports							
Read and interpret product information							
Read blueprints							

✓ = Necessary for the specified job

X = Desirable skill that may enhance employment

O = Optional skill that would seldom be needed

MATHEMATICS

COMPETENCIES

	MECHANIC	ELECTRICIAN	A/C REFRIG. TECHNICIAN	DRAFTER	COSMETOLOGIST		
Add, subtract, mulitply and divide whole numbers, decimals, fractions							
Round off numbers							
Raise number to a power (cube, square)							
Convert from decimals to fractions vice versa							
Determine percentage, percent (rate) base							
Compute average, mean, mode							
Compute simple interest							
Determine discount, commission							
Determine cost, profit, overhead							
Figure payroll and taxes							
Solve problems involving ratio and proportions							
Use graphs, charts, scales, and tables							
Add, subtract, multiply and divide units of measure							
Convert measures (English units to S.I. Metric units, vice versa							
Solve problems involving time, weight, distance, quantity, volume and area							
Perform operations using signed numbers							
Read guages, dials, and meters							
Compute tolerance							
Use measuring instruments such as ruler, protractor, compass, micrometer, caliper							
Use formulas to solve problems							
Express a problem in terms of mathematical equation							
Solve equations							
Apply order of operations							
Apply laws of exponents							
Graph equations							
Solve for multi unknowns							
Identify geometric shapes and lines							
Solve problems involving geometric shapes, angles, lines and points							
Solve problems that involve distance							
Determine functions of angles							

✓ - Necessary for the specified job

X - Desirable skill that may enhance employment

O - Optional skill that would seldom be needed

MATHEMATICS COMPETENCIES	MECHANIC	ELECTRICIAN	A/C REFRIG. TECHNICIAN	DRAFTER	COSMETOLOGIST		
Use trigometric tables							
Solve right triangle problems using sine, cosine, tangent and pythagorean theorem							
Solve problems involving oblique angles							
Apply radian measure to angles							
Solve trigometric equations							
Graph and chart trigometric results							
Use scientific calculator							
Use computer for computations							
Apply elementary statistics							
Perform statistical analysis							

✓ = Necessary for the specified job

X = Desirable skill that may enhance employment

O = Optional skill that would seldom be needed

REFERENCES

An Agenda for Action: Recommendations for School Mathematics of the 1980's. Ralston, VA.: National Council of Teachers of Mathematics, 1980. (ED 18625)

Agency for Instructional Technology. Applied Communication Information Handbook. Bloomington, IN: Agency for Instructional Technology, 1988.

Caffey, M. B. "The Cloze Procedure: A Measure for Determining Readability Levels for Vocational Junior College Students." Paper presented at the meeting of the Mid-South Education Research Association, Jackson, MS: 1975.

Campbell, Dale F. and Wood, Mary T. "General Education in the Occupational Curriculum: Why? To What Extent? With What Results?" In New Directions for Community Colleges, (58) Summer 1987, pp. 65-75.

Center for Occupational Research and Development. Instructional Design for Applied Mathematics. Waco, TX: Center for Occupational Research and Development, 1987.

Cumberland County College. Entry Level Basic Skills for Vocational Education. Final Report. Vineland, New Jersey: Cumberland County College, 1982. (ED 41722).

Diehl, W. and L. Mikulecky. "The Nature of Reading and Work." Journal of Reading (24) 1980: 221-227.

Educating Americans for the 21st Century: A Plan of Action for Science and Technology Education for All American Elementary and Secondary Students So That Their Achievement is the Best in the World by 1995. Washington, DC: National Science Board, Commission on Precollege Education in Mathematics, Science, and Technology, 1983.

Gillie, Scott W. and Kloosterman, Peter. "Basic Mathematical Skills for Vocational Education." Bridging Education and Employment with Basic Academic Skills. Bloomington, IN: Office of Education and Training Resources, School of Education, Indiana University, 1988.

Gray, James R. Applied Math and Science Levels Utilized in Selected Trade and Industrial Vocational Education. Final Report. Highland Heights: Northern Kentucky University, 1985. (ED 262293).

Greenan, James P. Identification of Generalizable Skills in Secondary Vocational Programs. Urbana: University of Illinois, Department of Vocational and Technical Education, 1983. (ED 233233).

Hamilton, Stephen I. "Excellence and the Transition from School to Work." Kappan, November 1986, pp. 239-242.

Karnes, F. A., and Ginn, Clyde N. Vocational Reading Development Program: Comparison of the Reading Comprehension Levels of the Postsecondary Vocational/Technical Students with the Readability Levels of the Textbooks Utilized in the Vocational Technical Complexes in Mississippi. Hattiesburg, MS: University of Southern Mississippi, 1976. (ED 137543).

Kern, R. P. "An Observational Method for Evaluating Use and Effectiveness of Technical Information Sources at a Work Site." In How People Use Technical Information on the Job. Washington, DC: American Institute for Research, 1980.

Liu, Cheng C. Literature Search. Teaching Basic Skills Through Vocational Education. Technical Report. Ithaca, New York: Cornell Institute for Occupational Education. State University of New York, 1980. (ED 217160).

Long, Thomas E. Basic Mathematics and Vocational Education. Columbus: National Center for Research in Vocational Education, The Ohio State University, 1980.

Lotto, Linda S. Building Basic Skills: Results from Vocational Education. Research and Development Series No. 237. Columbus: The Ohio State University, National Center for Research in Vocational Education, 1983. (ED 232015).

Miguel, Richard J., ed. Education and Employment: Where We Are and Where We Ought to Go. Columbus: The Ohio State University, National Center for Research in Vocational Education, 1985.

Mikulecky, L. "Job Literacy: The Relationship Between School Preparation and Workplace Actuality." Reading Research Quarterly, 17 (1982): 400-419.

Mikulecky, Larry and Drew, Rad A. "Basic Literacy and Communication Skills for Vocational Training." Bridging Education and Employment with Basic Academic Skills. Bloomington, IN: Office of Education and Training Resources, School of Education, Indiana University, 1988.

Mikulecky, L., and J. Ehlinger. "The Influence of Metacognitive Aspects of Literacy on Job Performance of Electronics Technicians." Journal of Reading Behavior, 18 (1986): 41-62.

Mikulecky, L. and D. Winchester. "Job Literacy and Job Performance Among Nurses at Varying Employment Levels." Adult Education Quarterly, 34 (1983): 1-15.

Perishing, James A. and Gillie, Scott W. "Basic Academic Skills in the Workplace and the Classroom: The Work-Education Bridge." Bridging Education and Employment with Basic Academic Skills. Bloomington, IN: Office of Education and Training Resources, School of Education, Indiana University, 1988.

Scott-Hunter, J. A. Student's Estimated Reading in Vocational-Technical Schools in Pennsylvania. University Park, PA: The Pennsylvania State University, 1978.

Thornton, L. Jay. Basic Reading Skills and Vocational Education. Columbus: National Center for Research in Vocational Education, The Ohio State University, 1980.